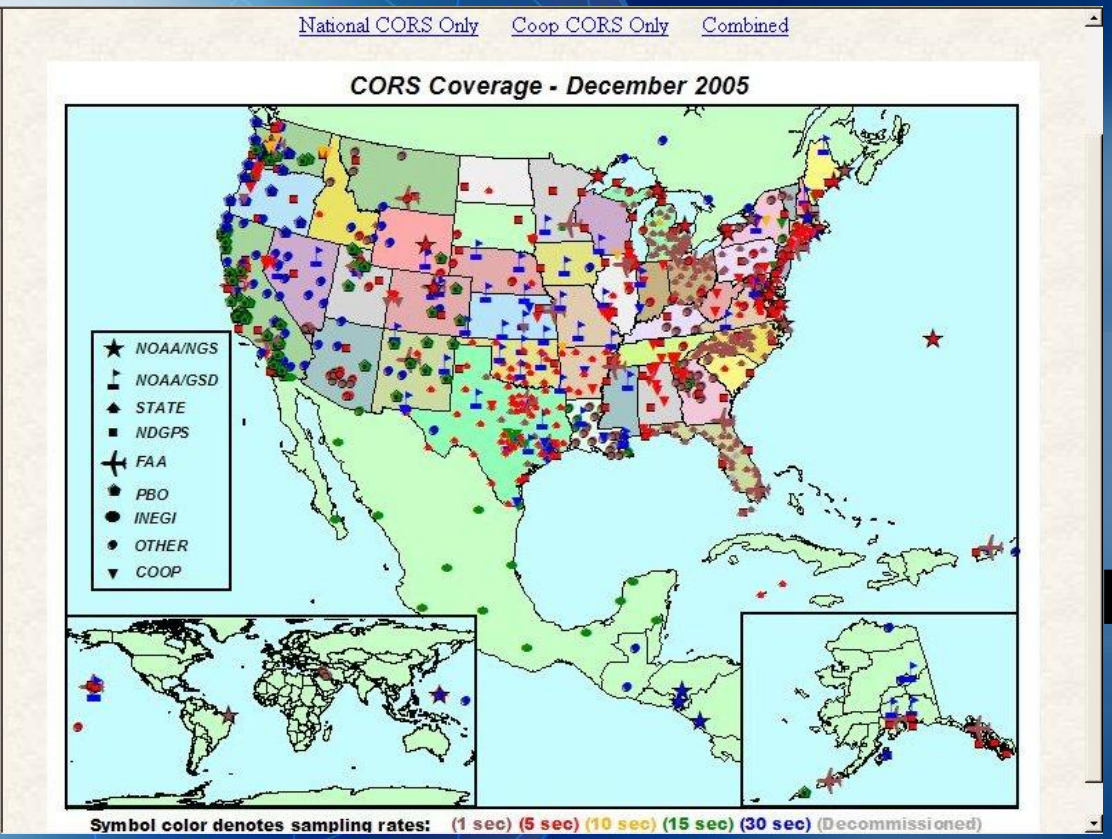
OPUS:

Online Positioning User Service

http://www.ngs.noaa.gov/OPUS/
ngs.opus@noaa.gov

WHAT IS OPUS?



- **O**n-line **P**ositioning **U**ser **S**ervice

- Fast & easy access to the NSRS (**National Spatial Reference System**) for GPS users

How Does OPUS Work?

- Data submitted through NGS web page
- Processed automatically with NGS computers & software
- Position with respect to 3 suitable CORS (or IGS sites if 1) no NAD 83 positions are available and 2) the host country has an agreement with NGS. In these international cases, ITRF coordinates only are returned, and there are no state plane or US grid coordinates
- Solution via email (usually in minutes)

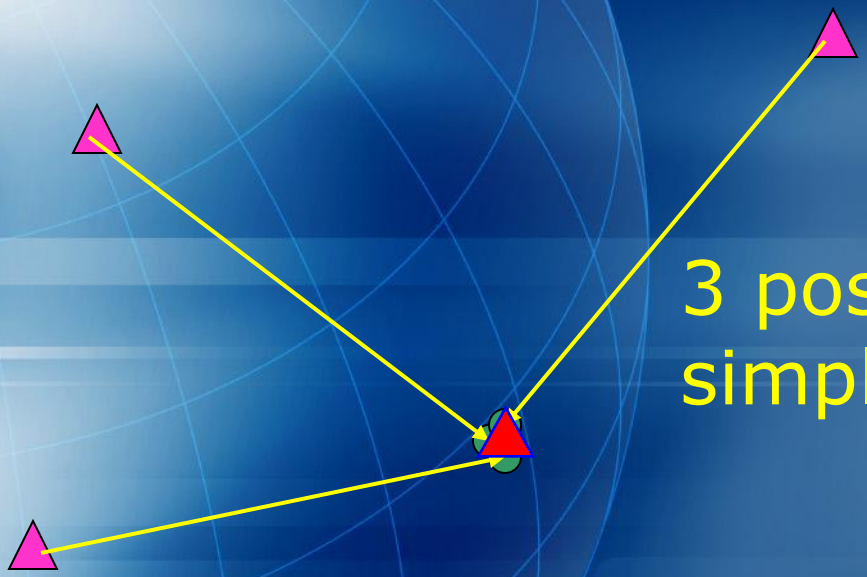
OPUS Guidelines

- Dual-frequency data (L1/L2)
- [recommended] Minimum 2 hrs of data (maximum 48—only cross midnight once)
- No kinematic data
- No Glonass. Galileo will be discussed as the constellation becomes available

Accurate height requires:
- correct antenna type
- correct antenna height

How Does OPUS Compute Position?

3 single baselines computed



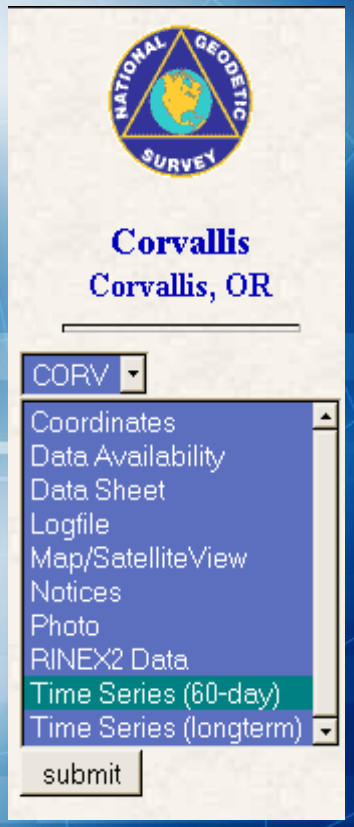
3 positions averaged — simple mean (equal weights)

Differences between positions include any errors in CORS coordinates

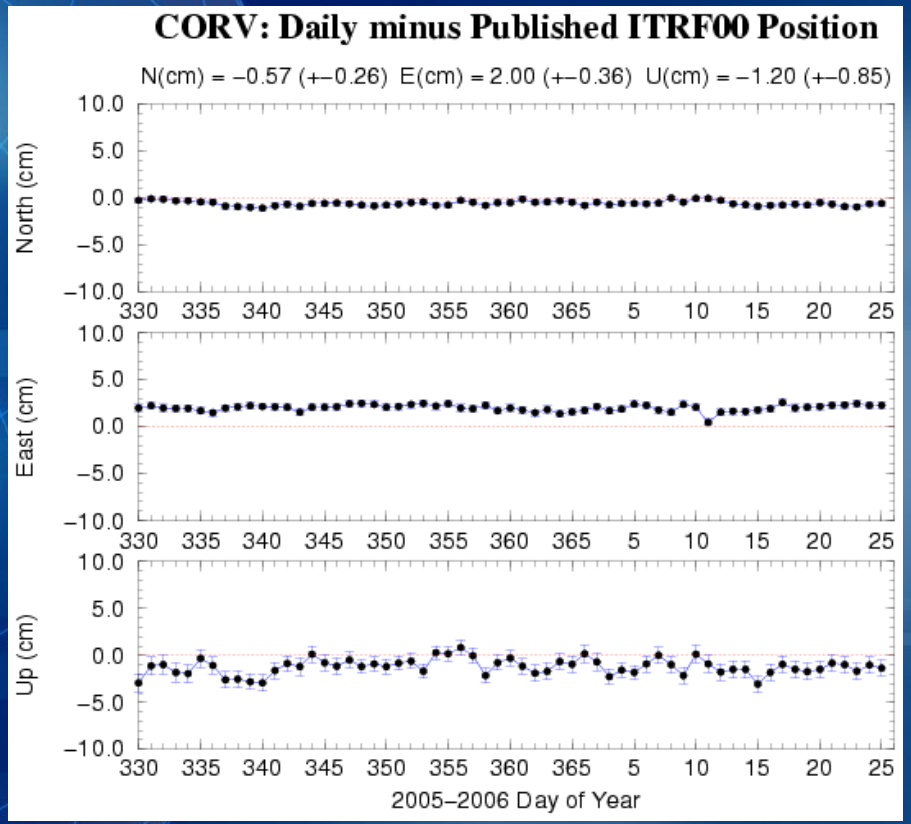
Time-series plots, 60-day and long-term

NATIONAL GEODETIC SURVEY

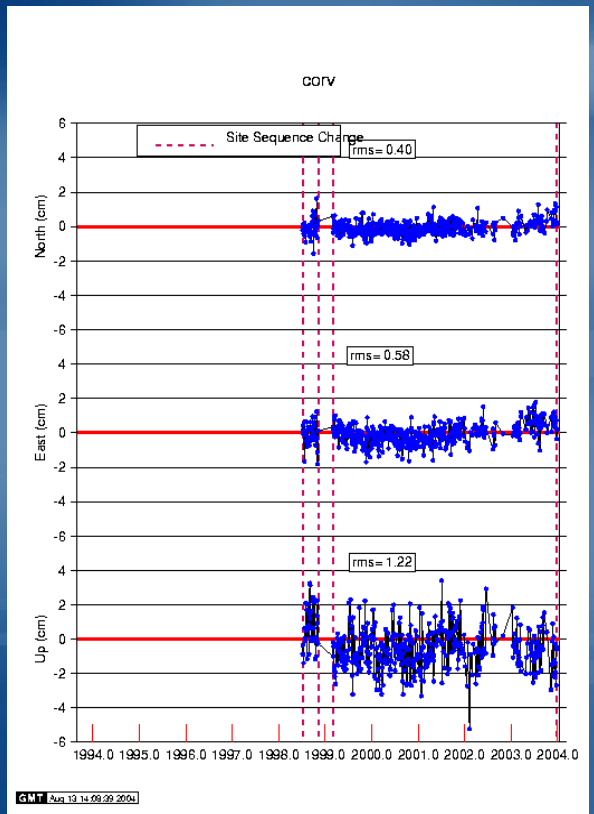
web page



60-day time series



Long-term time series



The time series plots provide a means of evaluating the small changes in position of a CORS.

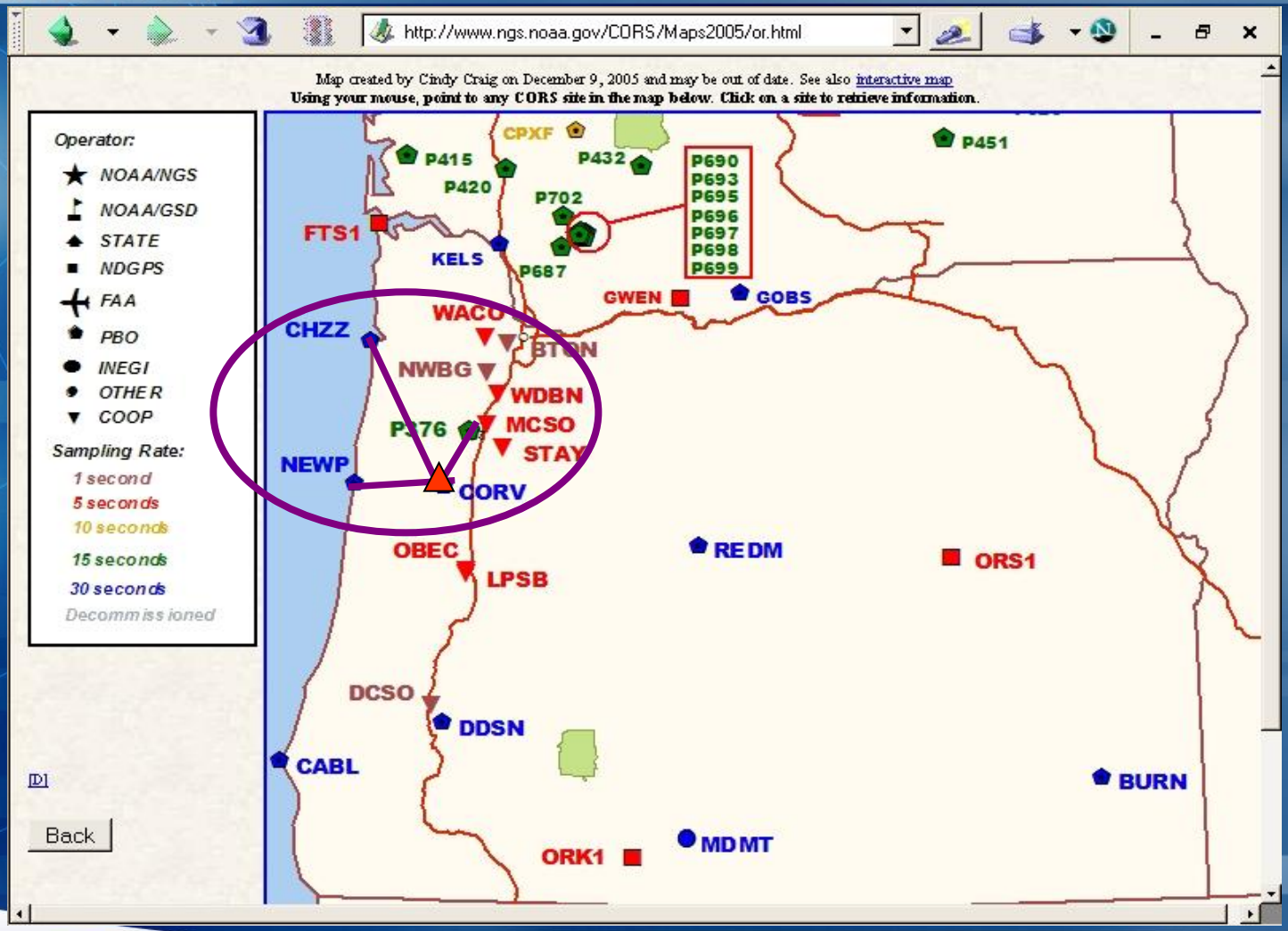
National Oceanic and Atmospheric Administration

How Does OPUS Pick Base Stations?

1. Estimate position for remote station
2. Compute distance to every available CORS
3. Sort CORS by increasing distance
4. Select the 5 closest CORS
5. Look at 1st 3 CORS with TEQC program. Criteria:
   - data cover time span for remote station
   - > 80% of data available
   - low multipath
   - if not, replace with 4th CORS (then 5th)
6. Start single baseline solutions using 1st 3 CORS
   - check solution quality
   - if bad solution, replace CORS with 4th (then 5th)

CORS Selection (example = CORV solved from CHZZ, NEWP, P376)

NATIONAL GEODETIC SURVEY



National Oceanic and Atmospheric Administration

U.S. DoC / NOAA / NOS / National Geodetic Survey - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address http://www.ngs.noaa.gov/

Go Links

Search Google AltaVista Ask Jeeves AlltheWeb LookSmart Customize this toolbar Highlight

mywebsearch Search Smiley Central My Info Fun Tools Games Customize My Button 1 Highlight

National Geodetic Survey

NGS, Positioning America for the Future

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Ocean Service

aeronautical data | CORS / OPUS GPS data | datasheets Find/Update a point | geodetic tool kit | PC software

Search for

Go

Site Map

What We Do

What's New

Products & Services

State Advisors

Contracting Opportunities

Our History

FAQ

Project & Division pages

Geoid

Geosciences Research (GRD)

Remote Sensing

FGCS/GIAC

Monday, March 15, 2004

• Upcoming Events • NGS In The News •

• *The Observer* Newsletter •

Check these out...

NGS Dedicates Commemorative Marker at U.S. Mint in Philadelphia: On March 12, NOAA dedicated a survey marker at the U.S. Mint in Philadelphia that commemorates Lewis and Clark's expedition across America two hundred years ago. ...*more info* ...Denver Mint dedication is March 15.

Cooperative CORS Providers/Users Group Meeting: The 2nd Annual Cooperative CORS Providers/Users Group Meeting will be held at the ACSM conference in Nashville. ...*more info*

New Options added to OPUS: This new version of OPUS optionally allows users control over which CORS sites are used for a solution, to receive their output in an extended format, and have their solution computed in State Plane coordinates. See Option #5 on the OPUS main page.

Lewis And Clark Bicentennial: To honor Lewis and Clark's contributions to mapping, NGS is installing a series of commemorative markers along the route that Lewis and Clark traveled.

The National Readjustment

NGS plans the readjustment of horizontal positions and ellipsoid

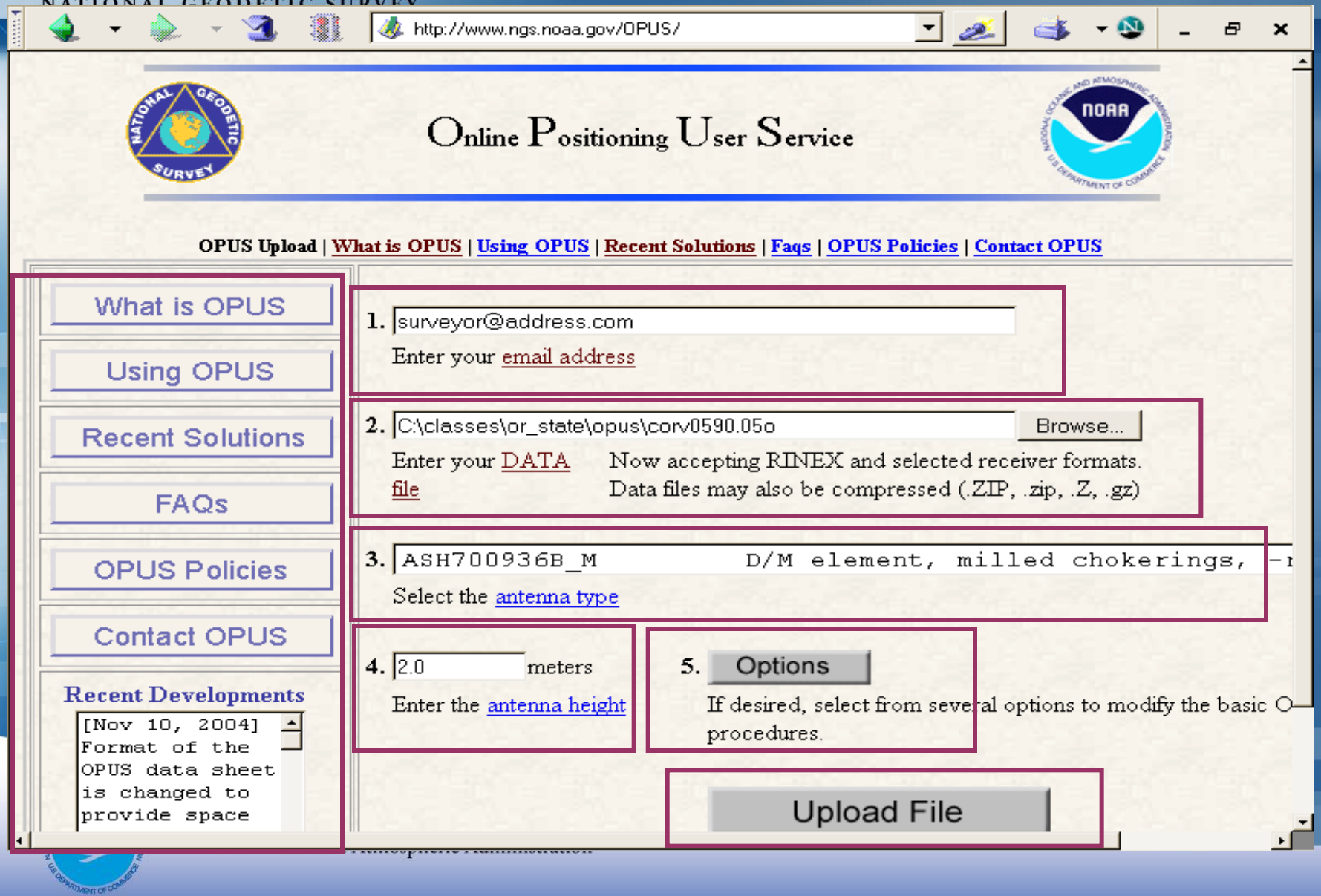
Quick Link to OPUS from NGS Home Page

www.ngs.noaa.gov

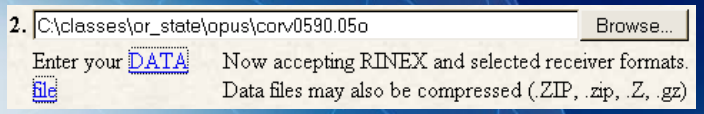
Done

Internet

Using the OPUS Web Page



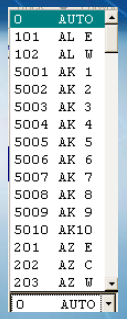
Allowable Data Formats



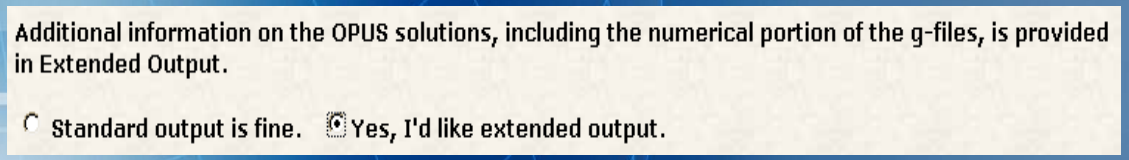
- RINEX Receiver Independent Exchange--uncompressed
- Manufacturer's native / raw (binary)—uncompressed--as long as UNAVCO's teqc program can process it
- Compressed archive of multiple files. Archive must contain RINEX "site123h.04o" or Hatanaka "site123h.04d"
- Compressed individual files."Site123h.zip"must contain "site123h.06o" or "site123h.06d"

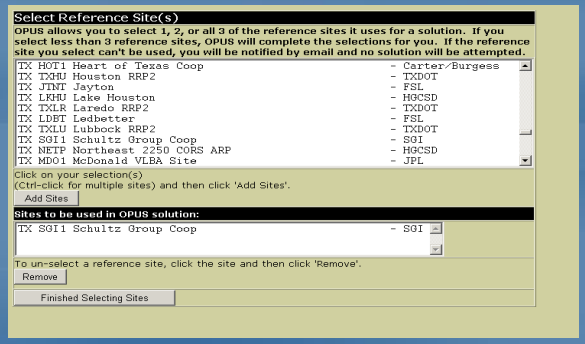
Options

NATIONAL GEODETIC SURVEY



- Select state plane coordinate zone
- Select or exclude base stations including Cooperative CORS
- Extended Output





- Set user profile

Associate antenna type, antenna height, SPC code, selected base stations and extended option choices with your email address

OPUS Output
Standard

NATIONAL GEODETIC SURVEY

National Oceanic and Atmosph

```
FILE: corv0590.05o 000416827

 1008   NOTE:  Antenna offsets supplied by the user were zero.  Coordinates
 1008   returned will be for the antenna reference point (ARP).
 1008

                              NGS OPUS SOLUTION REPORT
                              ========================

      USER: jeff.olsen@noaa.gov                    DATE: January 13, 2006
RINEX FILE: corv059f.05o                           TIME: 19:08:14 UTC


  SOFTWARE: page5  0601.10 master3.pl            START: 2005/02/28  05:00:00
 EPHEMERIS: igs13121.eph [precise]                STOP: 2005/02/28  06:59:30
  NAV FILE: brdc0590.05n                      OBS USED:  4228 /  4314   :  98%
  ANT NAME: ASH700936B_M    NONE            # FIXED AMB:    25 /    29   :  86%
ARP HEIGHT: 0.0                             OVERALL RMS: 0.013(m)

 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)            ITRF00 (EPOCH:2005.1596)

         X:     -2498423.165(m)    0.018(m)          -2498423.872(m)    0.018(m)
         Y:     -3802822.048(m)    0.021(m)          -3802820.836(m)    0.021(m)
         Z:      4454737.695(m)    0.024(m)           4454737.792(m)    0.024(m)

       LAT:   44 35  7.91054      0.002(m)        44 35  7.92698      0.002(m)
     E LON:  236 41 43.48129      0.014(m)       236 41 43.42434      0.014(m)
     W LON:  123 18 16.51871      0.014(m)       123 18 16.57566      0.014(m)
    EL HGT:          107.485(m)    0.034(m)               107.108(m)    0.034(m)
 ORTHO HGT:          130.010(m)    0.043(m) [Geoid03 NAVD88]

                         UTM COORDINATES    STATE PLANE COORDINATES
                          UTM (Zone 10)         SPC (3601 OR N)
Northing (Y) [meters]     4936954.907           105971.557
Easting (X)  [meters]      475821.322          2277335.385
Convergence  [degrees]    -0.21381402          -1.98897497
Point Scale                0.99960719           0.99994603
Combined Factor            0.99959034           0.99992918

US NATIONAL GRID DESIGNATOR: 10TDQ7582136955(NAD 83)

                              BASE STATIONS USED
PID       DESIGNATION                        LATITUDE    LONGITUDE DISTANCE(m)
AH2489 NEWP NEWPORT CORS ARP              N443506.072 W1240342.736   60138.7
AJ6959 CHZZ CAPE MEARS CORS ARP           N452911.437 W1235841.187  113322.4
DH4503 P376 EOLARESVR_OR2004 CORS ARP     N445628.313 W1230608.100   42648.2

                     NEAREST NGS PUBLISHED CONTROL POINT
AH2486      CORVALLIS CORS ARP            N443507.910 W1231816.519       0.0
```

Reading OPUS Output

NATIONAL GEODETIC SURVEY

```
 USER: jeff.olsen@noaa.gov                    DATE: January 13, 2006
RINEX FILE: corv059f.05o                          TIME: 19:08:14 UTC

  SOFTWARE: page5  0601.10 master3.pl          START: 2005/02/28  05:00:00
 EPHEMERIS: igs13121.eph [precise]              STOP: 2005/02/28  06:59:30
  NAV FILE: brdc0590.05n                     OBS USED:  4228 /  4314   :  98%
  ANT NAME: ASH700936B_M    NONE          # FIXED AMB:    25 /    29   :  86%
ARP HEIGHT: 0.0                           OVERALL RMS: 0.013(m)
```

- Your email address & observation file. Solution run date & time
- The version of PAGES software used for processing
- The ephemeris used (OPUS will use the best available):
  "igs" final post-fit orbit--better than 1 cm (10-14 days wait)
  "igr" rapid post-fit orbit--better than 2 cm (17 hours wait)
  "igu" ultra-rapid predicted orbit--better than 20 cm (available immediately)
- Navigation file used
- The antenna type you selected and height of antenna reference point height you entered. Confirm that these are correct.

National Oceanic and Atmospheric Administration

Reading OPUS Output con't.


```
 USER: jeff.olsen@noaa.gov                    DATE: January 13, 2006
RINEX FILE: corv059f.05o                          TIME: 19:08:14 UTC

  SOFTWARE: page5  0601.10 master3.pl     START: 2005/02/28  05:00:00
 EPHEMERIS: igs13121.eph [precise]         STOP: 2005/02/28  06:59:30
  NAV FILE: brdc0590.05n                OBS USED:  4228 /  4314   :  98%
  ANT NAME: ASH700936B_M    NONE      # FIXED AMB:    25 /    29   :  86%
ARP HEIGHT: 0.0                       OVERALL RMS: 0.013(m)
```

- Start & end dates & times of your file
- Ratio and % of observations used in solution
- Ratio and % of fixed/total ambiguities
- Overall RMS of the solution

Guidelines for Good Solution

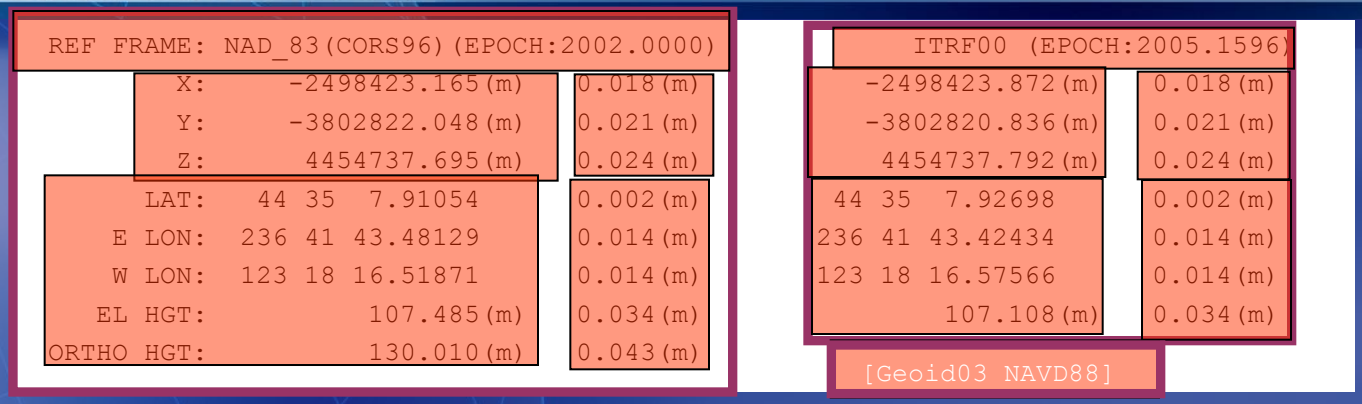
- Make sure antenna type and height are correct

- Review statistics:
  - at least 90% of observations should be used
    - OBS USED: 4228 / 4314 : 98%
  - at least 50% of the ambiguities should be fixed
    - # FIXED AMB: 25 / 29 : 86%
  - overall RMS should seldom exceed 0.030 m
    - OVERALL RMS: 0.013(m)

- In case of bad statistics, try choosing different CORS and re-submit.

Reading OPUS Output con't.
Solution/Coordinates

NATIONAL GEODETIC SURVEY

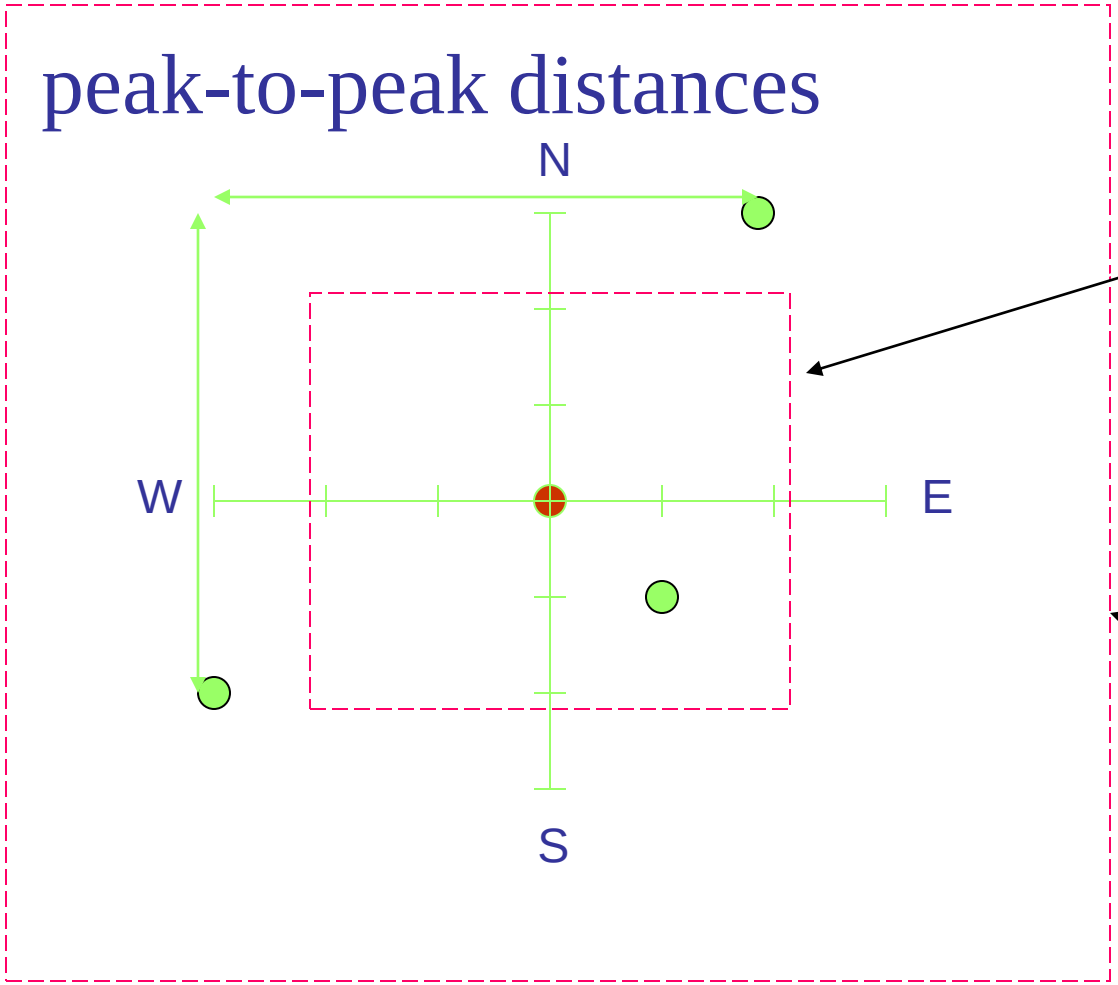


REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)		
X:	-2498423.165(m)	0.018(m)
Y:	-3802822.048(m)	0.021(m)
Z:	4454737.695(m)	0.024(m)
LAT:	44 35 7.91054	0.002(m)
E LON:	236 41 43.48129	0.014(m)
W LON:	123 18 16.51871	0.014(m)
EL HGT:	107.485(m)	0.034(m)
ORTHO HGT:	130.010(m)	0.043(m)

ITRF00 (EPOCH:2005.1596)		
	-2498423.872(m)	0.018(m)
	-3802820.836(m)	0.021(m)
	4454737.792(m)	0.024(m)
	44 35 7.92698	0.002(m)
	236 41 43.42434	0.014(m)
	123 18 16.57566	0.014(m)
	107.108(m)	0.034(m)
[Geoid03 NAVD88]		

- Reference frames. Epochs
- Position, xyz
- Peak-peak errors, xyz (range, max-min)
- Position, lat / long / eh / oh
- Peak-peak for lat/long etc
- Peak-peak errors may vary between NAD83 & ITRF
- Orthometric ht. is based on current geoid model

How Does OPUS Compute Errors?



1 σ standard deviation

peak-to-peak error

more conservative
~ 2 σ

OPUS Output con't.
Grid Coordinates

NATIONAL GEODETIC SURVEY

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	4936954.907	105971.557
Easting (X) [meters]	475821.322	2277335.385
Convergence [degrees]	-0.21381402	-1.98897497
Point Scale	0.99960719	0.99994603
Combined Factor	0.99959034	0.99992918

US NATIONAL GRID DESIGNATOR: 10TDQ7582136955(NAD 83)

- Universal Transverse Mercator (UTM) coordinates
  - US National Grid
- State Plane coordinates (if requested)

READING OPUS OUTPUT (control)

NATIONAL GEODETIC SURVEY

```
•     BASE STATIONS USED
•    PID        DESIGNATION                        LATITUDE     LONGITUDE DISTANCE(m)
•    AH2489 NEWP NEWPORT CORS ARP                N443506.072 W1240342.736   60138.7
•    AJ6959 CHZZ CAPE MEARS CORS ARP             N452911.437 W1235841.187  113322.4
•    DH4503 P376 EOLARESVR_OR2004 CORS ARP       N445628.313 W1230608.100   42648.2

•                    NEAREST NGS PUBLISHED CONTROL POINT
•    AH2486      CORVALLIS CORS ARP              N443507.910 W1231816.519       0.0

•    This position and the above vector components were computed without any
•    knowledge by the National Geodetic Survey regarding the equipment or
•    field operating procedures used.
```

- Base Stations--NAD83 position--distance away
- The closest published station in the NGS data base

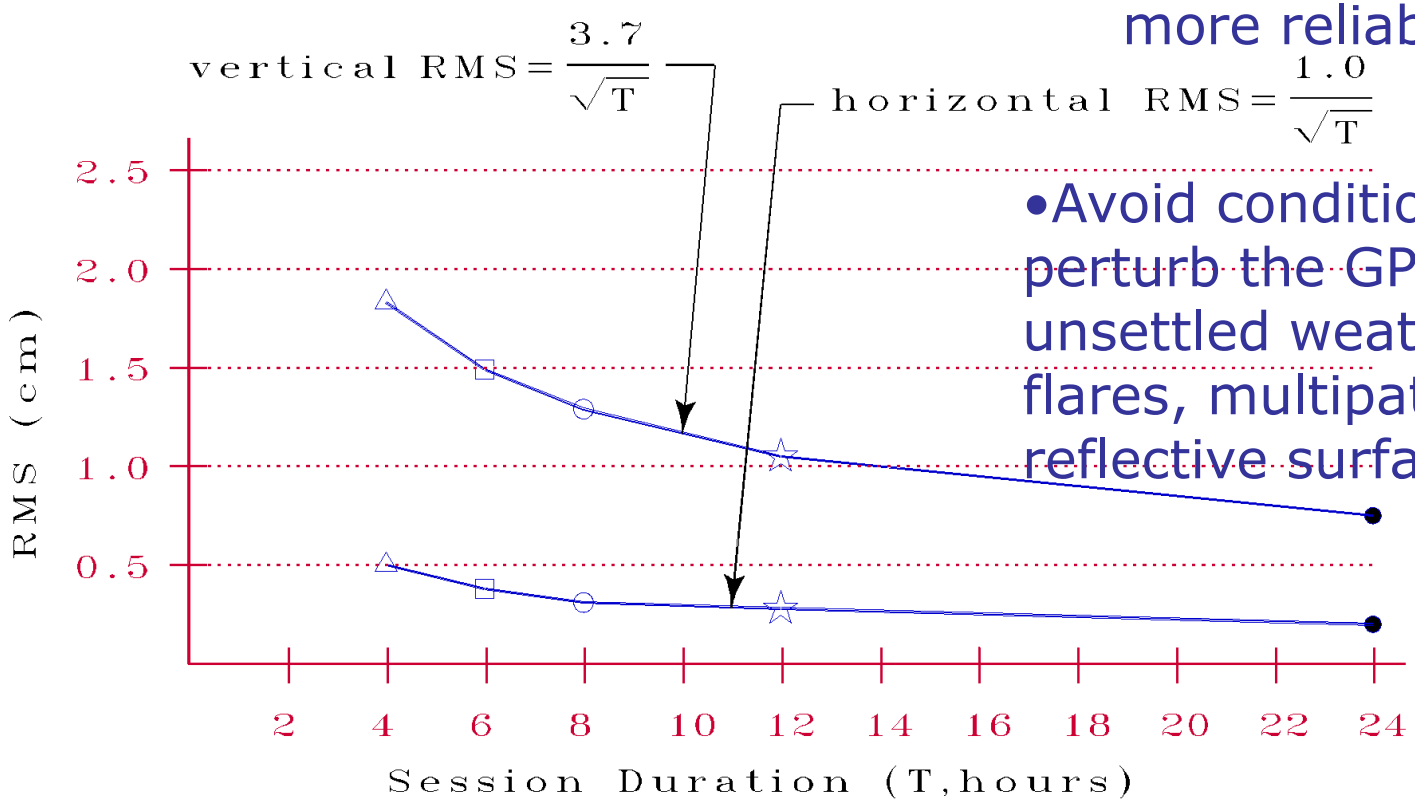
  In case you didn't know it was there

- Disclaimer

National Oceanic and Atmospheric Administration

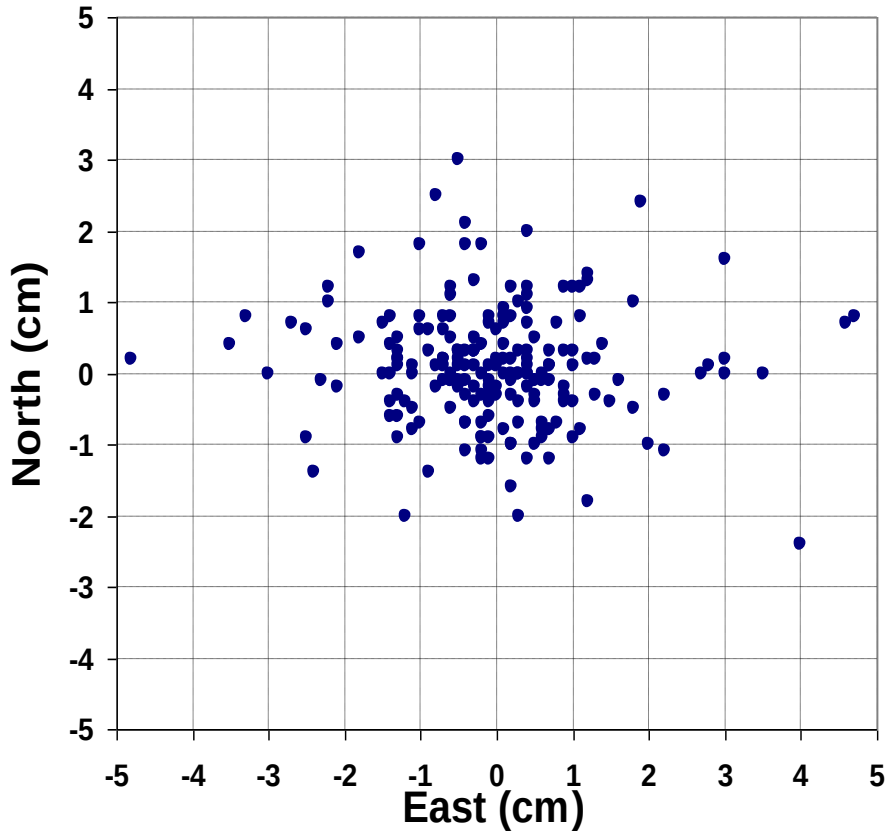
How Can I Improve My Results?

- Consider observing a longer session
- Data sets of at least four hours have been shown to produce more reliable results



- Avoid conditions that perturb the GPS signal—unsettled weather, solar flares, multipath (nearby reflective surfaces)

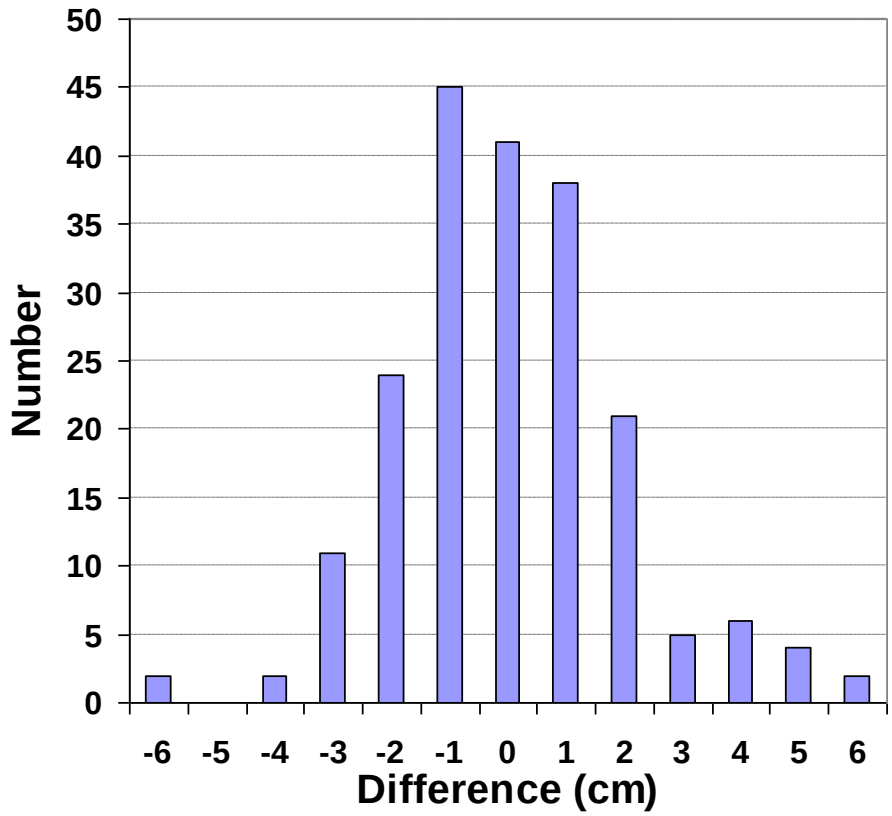
Distribution of Horizontal Offset from Accepted Values



- > 200 CORS
- 2 hours of data

- 0.8 cm N-S RMS
- 1.4 cm E-W RMS

Distribution of Vertical Offset from Accepted Values



- > 200 CORS
- 2 hours of data

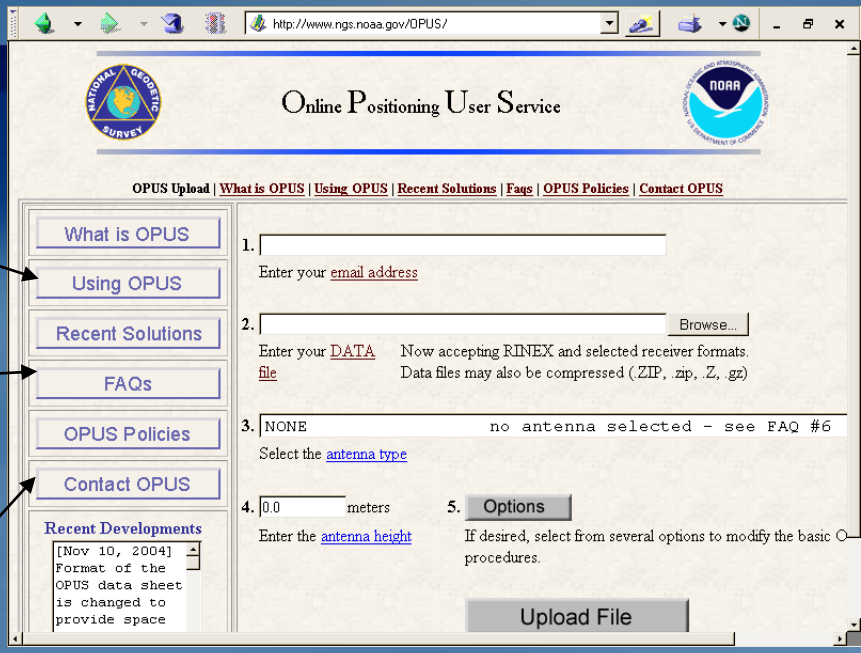
- 1.9 cm RMS
- All mean offsets < 1 mm

How do I get help?

- Study the Guidelines under "Using OPUS"

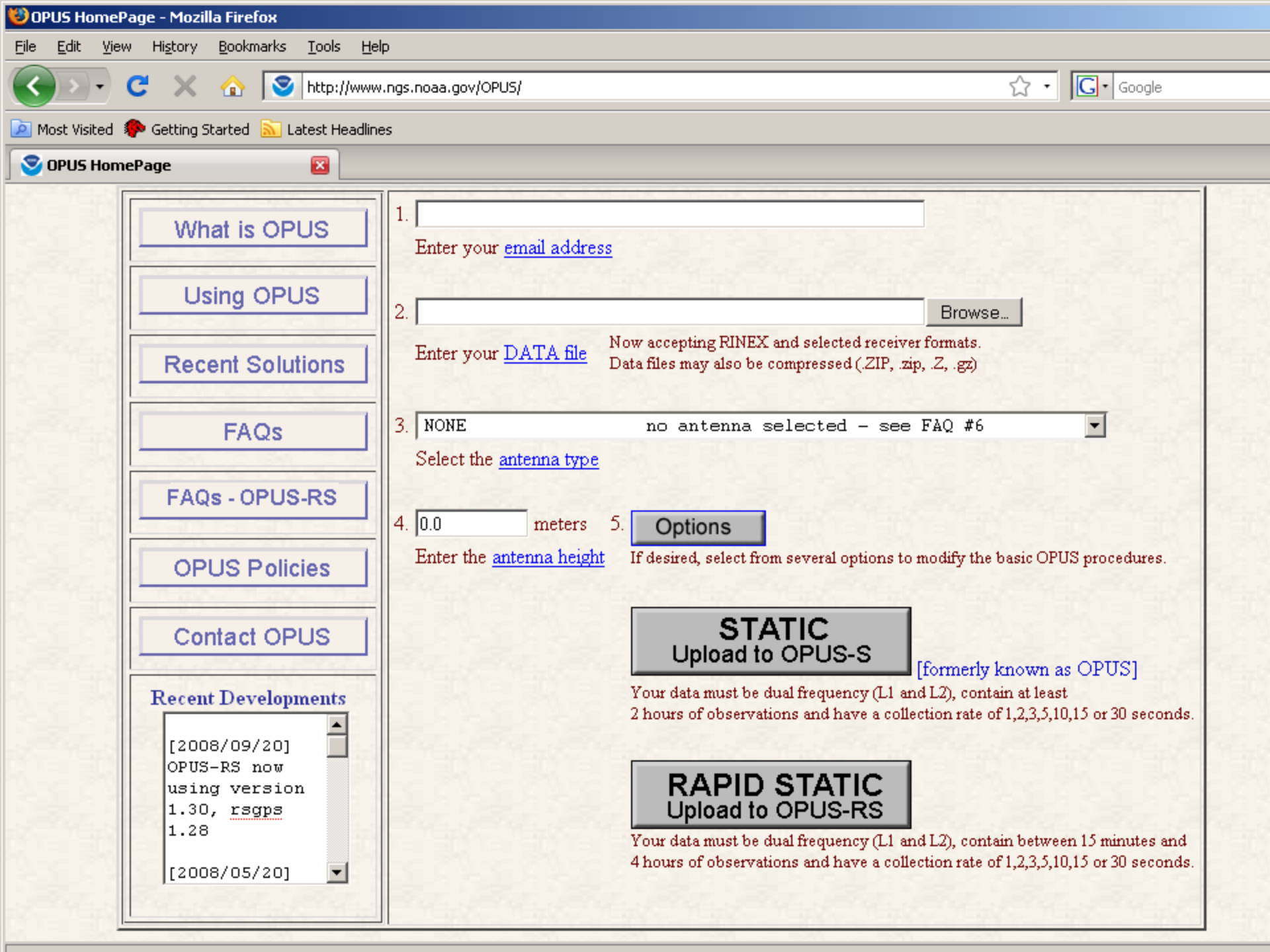
- Study the answers under "FAQs"

- Submit specific questions, comments or suggestions using "Contact OPUS" link



Getting There Faster –

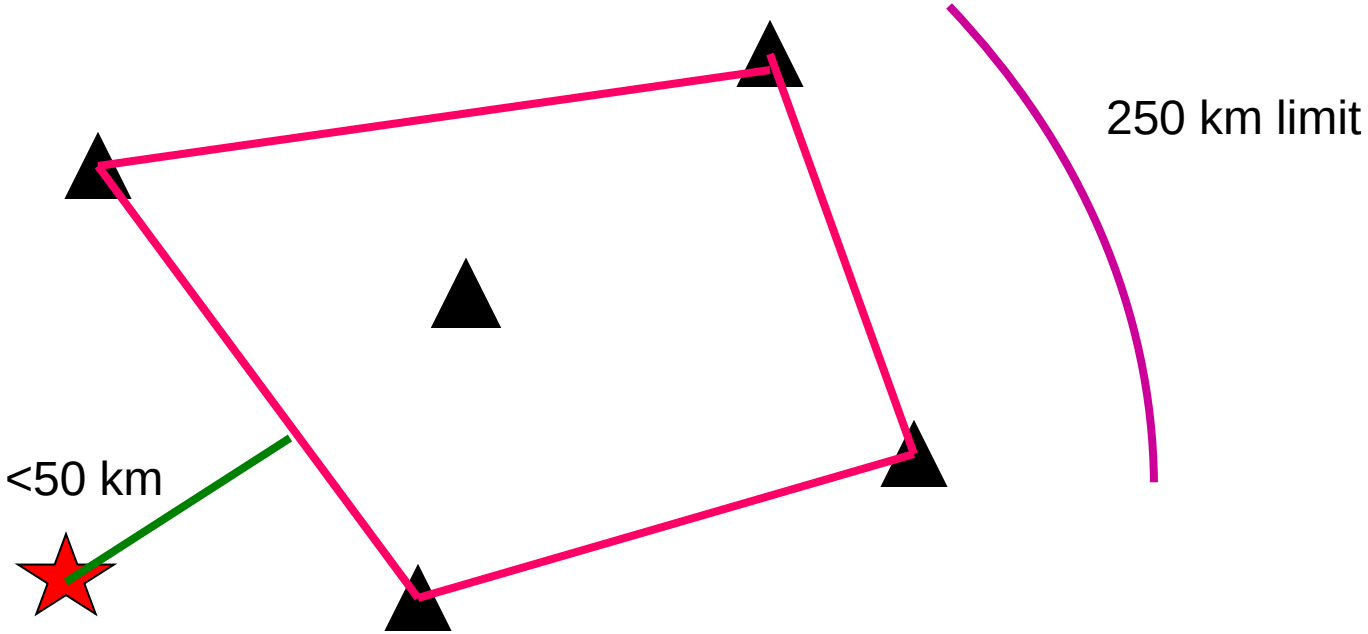
The RSGPS program and OPUS - RS


OPUS HomePage - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://www.ngs.noaa.gov/OPUS/
Google
Most Visited Getting Started Latest Headlines
OPUS HomePage
What is OPUS
Using OPUS
Recent Solutions
FAQs
FAQs - OPUS-RS
OPUS Policies
Contact OPUS
Recent Developments
[2008/09/20]
OPUS-RS now
using version
1.30, rsgps
1.28
[2008/05/20]
1.
Enter your email address
2.
Browse...
Enter your DATA file
Now accepting RINEX and selected receiver formats.
Data files may also be compressed (.ZIP, .zip, .Z, .gz)
3.
NONE no antenna selected - see FAQ #6
Select the antenna type
4.
0.0
meters
5.
Options
Enter the antenna height
If desired, select from several options to modify the basic OPUS procedures.
STATIC
Upload to OPUS-S
[formerly known as OPUS]
Your data must be dual frequency (L1 and L2), contain at least
2 hours of observations and have a collection rate of 1,2,3,5,10,15 or 30 seconds.
RAPID STATIC
Upload to OPUS-RS
Your data must be dual frequency (L1 and L2), contain between 15 minutes and
4 hours of observations and have a collection rate of 1,2,3,5,10,15 or 30 seconds.

OPUS-RS

- Uses RSGPS program instead of PAGES
- Uses P1 and P2 as well as L1 and L2 obs
- Resolves all ambiguities with LAMBDA
- Geometry free linear combination used to determine DD ionospheric delays

OPUS-RS search algorithm



•Sort stations in CORS network by distance from rover. Select up to nine CORS that are less than 250 km from rover and that have suitable data.

•No solution is attempted if fewer than three CORS selected.

•No solution attempted if distance from rover to polygon enclosing selected CORS is greater than 50 km.

OPUS-RS

RSGPS is based (conceptually) on the MPGPS program developed at the Ohio State University

- OPUS-RS uses RSGPS in two modes:
  Network and Rover

- In network mode, at least one hour of data from the selected CORS are used to solve for ambiguities, tropospheric refraction, and double difference ionospheric delays at these CORS. The positions of the CORS are held fixed.

- In rover mode, ionospheric delays and troposphere parameters are interpolated (or extrapolated) from the selected CORS to rover. Then the delays at the rover are constrained to solve for the position of the rover. Again, the positions of the CORS are held fixed.

OPUS-RS

Produces solution with 15 minutes of data

(vs. 2 hours for current OPUS)

To improve accuracy and reliability:

- Collect observations for more than 15 minutes
- Perform multiple observing sessions
- Avoid conditions that perturb the GPS signal—unsettled weather, solar flares, multipath (nearby reflective surfaces)

OPUS-RS

- User interface is almost identical to regular OPUS, including Options page
- Output report is similar to regular OPUS, but with quality indicators based on the W-ratio from the LAMBDA validation tests
- The normalized RMS is a unitless measure of the scatter in the data misfits
- No peak-to-peak variations

OPUS-RS Output Report

```
                        NGS OPUS-RS SOLUTION REPORT
                        ===========================

      USER: rick.foote@noaa.gov                    DATE: March 16, 2007
RINEX FILE: vari045a.07o                           TIME: 11:40:07 UTC


  SOFTWARE: rsgps  1.06 RS26.prl                  START: 2007/02/14 00:00:30
 EPHEMERIS: igs14143.eph [precise]                 STOP: 2007/02/14 00:59:30
  NAV FILE: brdc0450.07n                       OBS USED:  2784 /  2994   :  93%
  ANT NAME: TRM41249.00                     QUALITY IND.  21.91/ 64.08
ARP HEIGHT: 2.0                           NORMALIZED RMS:       0.295

 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)          ITRF00 (EPOCH:2007.12086)

         X:      1108081.771(m)  see                 1108081.069(m)  see
         Y:     -4958243.092(m)  accuracy           -4958241.626(m)  accuracy
         Z:      3843038.534(m)  note                3843038.407(m)  note

       LAT:   37 17 23.88604                      37 17 23.91389
     E LON:  282 35 51.40742                     282 35 51.39258
     W LON:   77 24  8.59258                      77 24  8.60742
    EL HGT:          -10.287(m)                          -11.624(m)
 ORTHO HGT:           23.244(m)              [Geoid03 NAVD88]

UTM COORDINATES    STATE PLANE COORDINATES
                        UTM (Zone 18)          SPC (4502 VA S)
Northing (Y) [meters]     4129746.071          1106727.888
Easting (X)  [meters]      287042.763          3597320.710
Convergence  [degrees]    -1.45603091           0.66616871
Point Scale                1.00015868           0.99994631
Combined Factor            1.00016029           0.99994793
```

OPUS-S vs. OPUS-RS

What are the fundamental differences between OPUS-Static (OPUS-S) and OPUS-Rapid Static (OPUS-RS)?

OPUS-S vs. OPUS-RS

OPUS-S requires at least two hours of GPS data from the rover, together with the same amount of data from 3 CORS (preferably located within 600 km of the rover), to solve for

* the rover's coordinates,

* atmospheric refraction parameters at both the rover and the 3 CORS, and

* integer ambiguities (in the doubly differenced phase observations).

OPUS-S vs. OPUS-RS

OPUS-RS involves a 3-step process:

* Use at least one hour of GPS data from 3 to 9 CORS (located within 250 km of the rover) to solve for atmospheric refraction parameters at these CORS.
* Interpolate (or extrapolate) these refraction parameters to predict corresponding refraction parameters at the rover.
* Use at least 15 minutes of GPS data at the rover, together with the same amount of data at the nearby CORS to solve for:
  - the rover's coordinates and
  - integer ambiguities.

OPUS-S vs. OPUS-RS

Requirement	OPUS-S	OPUS-RS
Amount of GPS data from rover	2 – 48 hours	0.25 – 4.00 hours
Local CORS geometry	3 CORS, preferably located within 600 km of rover	3 to 9 CORS located within 250 km of rover, preferably with IDOP < 0.8

What is IDOP?

The interpolative dilution of precision (IDOP) is a unitless number that quantifies the local geometric strength of the CORS network relative to the rover's location in terms of how well atmospheric conditions at nearby CORS can be interpolated (or extrapolated) to predict corresponding atmospheric conditions at the rover.

What is IDOP?

If there are several (at least 3) CORS located within 250 km of the rover and we have estimated an atmospheric parameter for each of these CORS with a standard error of σ,

then the corresponding atmospheric parameter at the rover can be predicted with a standard error of

$$\sigma_R = (\text{IDOP}) \bullet \sigma \ .$$

Hence, the smaller the value of IDOP the better.

What is IDOP?

Let (x_i , y_i) denote the location of the i-th CORS in the xy-plane for i = 1,2,3,…,n
and let (x_0 , y_0) denote the location of the rover in the xy-plane, then

$$IDOP = (R/Q)^{0.5}$$

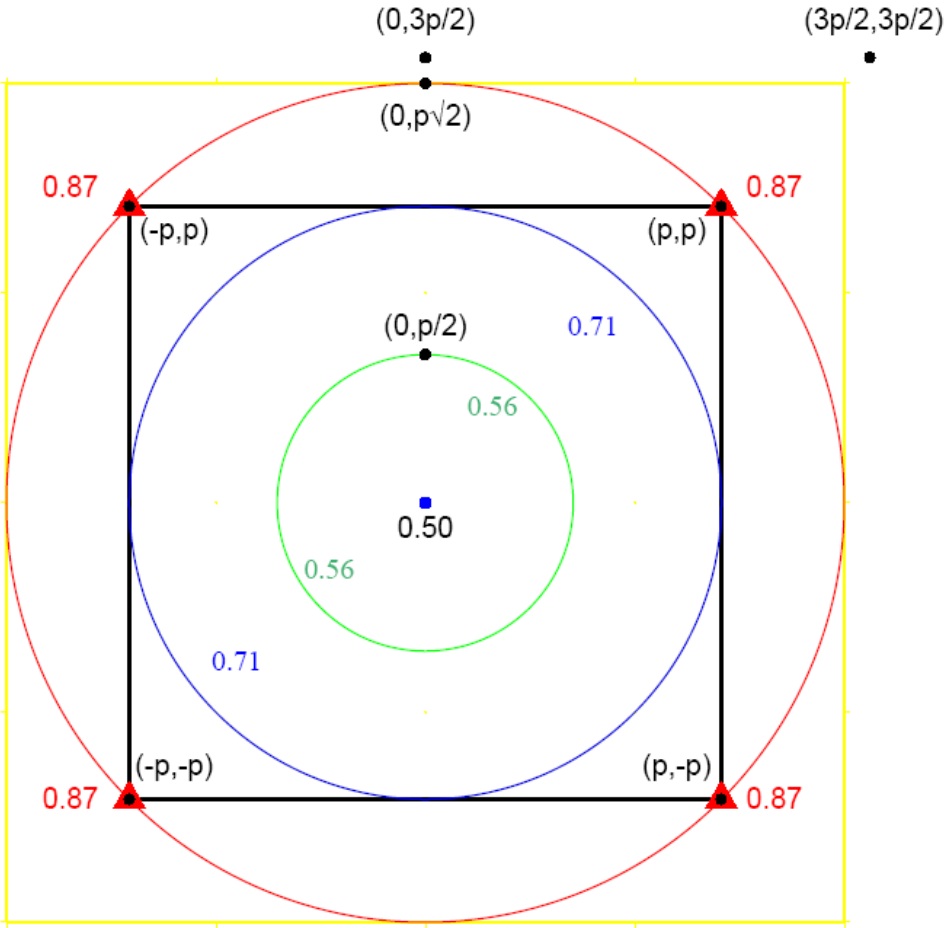
where $R = (\sum \Delta x_i^2)(\sum \Delta y_i^2) - (\sum \Delta x_i \Delta y_i)^2$

and $Q = nR + 2(\sum \Delta x_i)(\sum \Delta y_i)(\sum \Delta x_i \Delta y_i) - (\sum \Delta x_i)^2(\sum \Delta y_i^2) - (\sum \Delta y_i)^2(\sum \Delta x_i^2)$

Here $\Delta x_i = x_i - x_0$ and $\Delta y_i = y_i - y_0$ for i = 1,2, 3,…,n.

IDOP VALUES AS A FUNCTION OF LOCATION
EXAMPLE FOR THE CASE OF 4 CORS LOCATED AT THE CORNERS OF A SQUARE

- **Best IDOP =** $1/\sqrt{N}$ **where N denotes the number of CORS. Best IDOP occurs at the centroid of the CORS.**
-
- **With these 4 CORS, the best IDOP = 0.5 and IDOP increases as the distance of the rover from the centroid increases.**

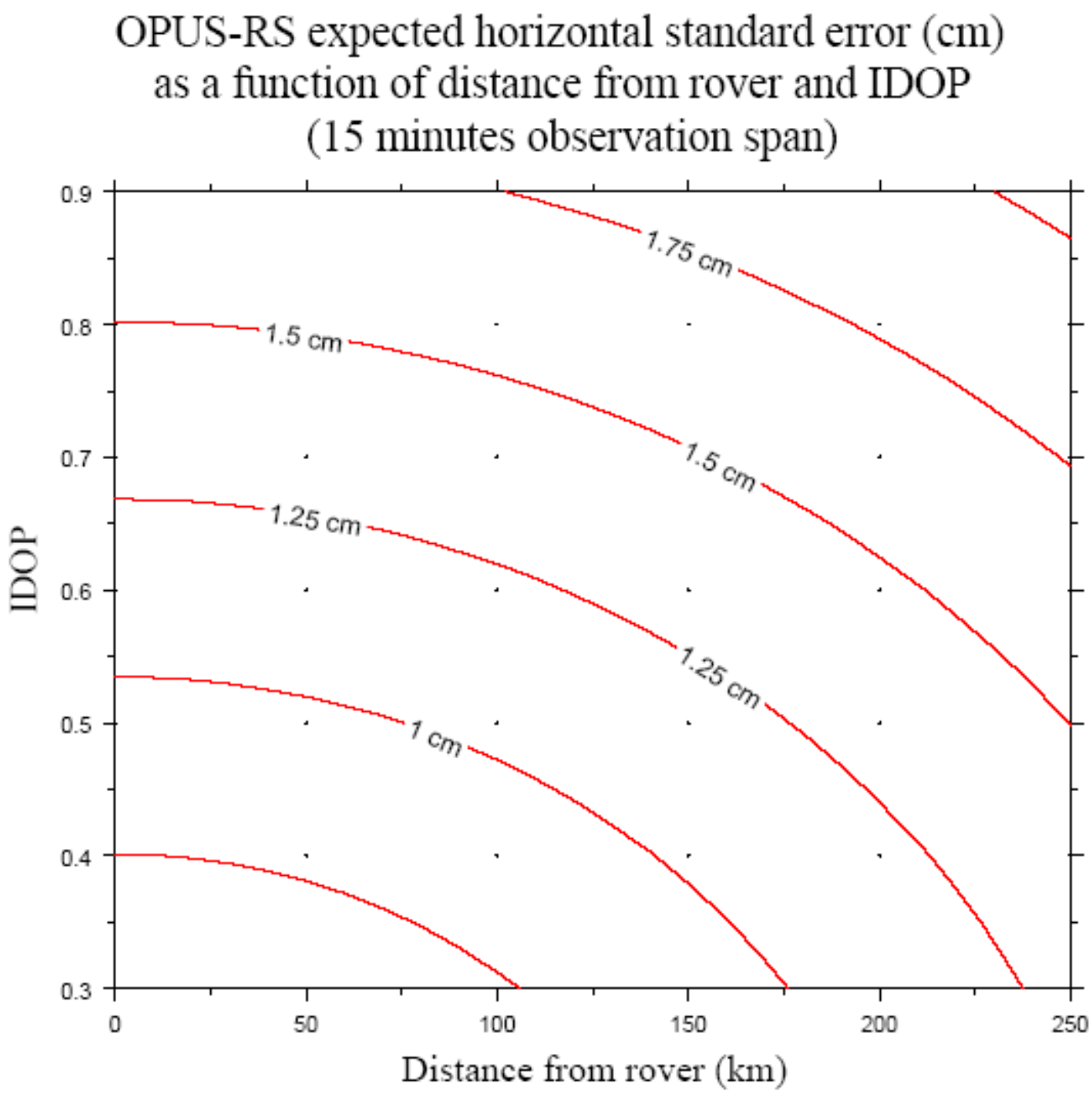


OPUS-RS Accuracy Depends on both IDOP and RMSD

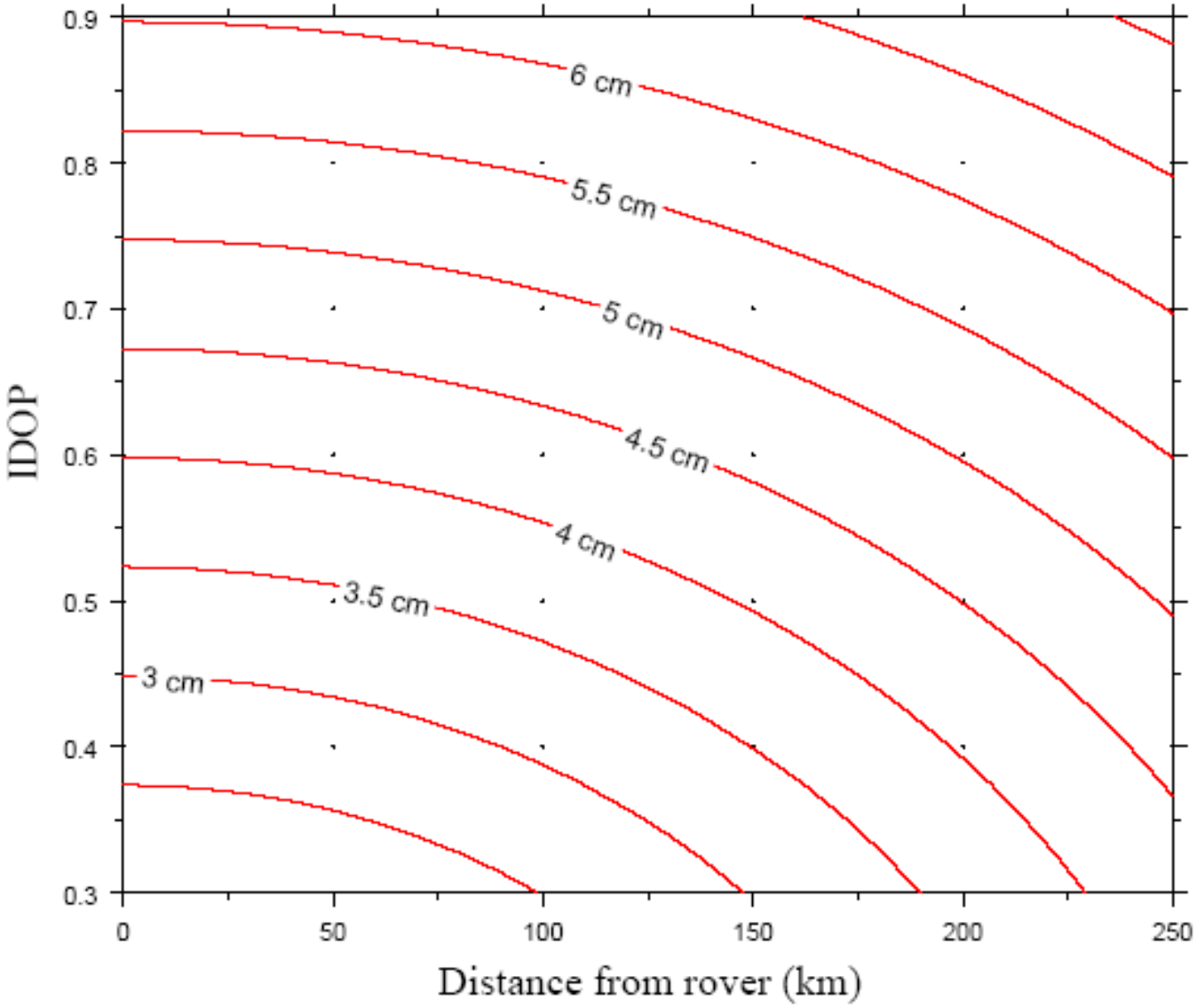
RMSD = Root mean square distance = $[(\sum d_i^2) / n]^{0.5}$

where d_i is the distance between the rover
and the i-th CORS,
and n equals the number of CORS being used.

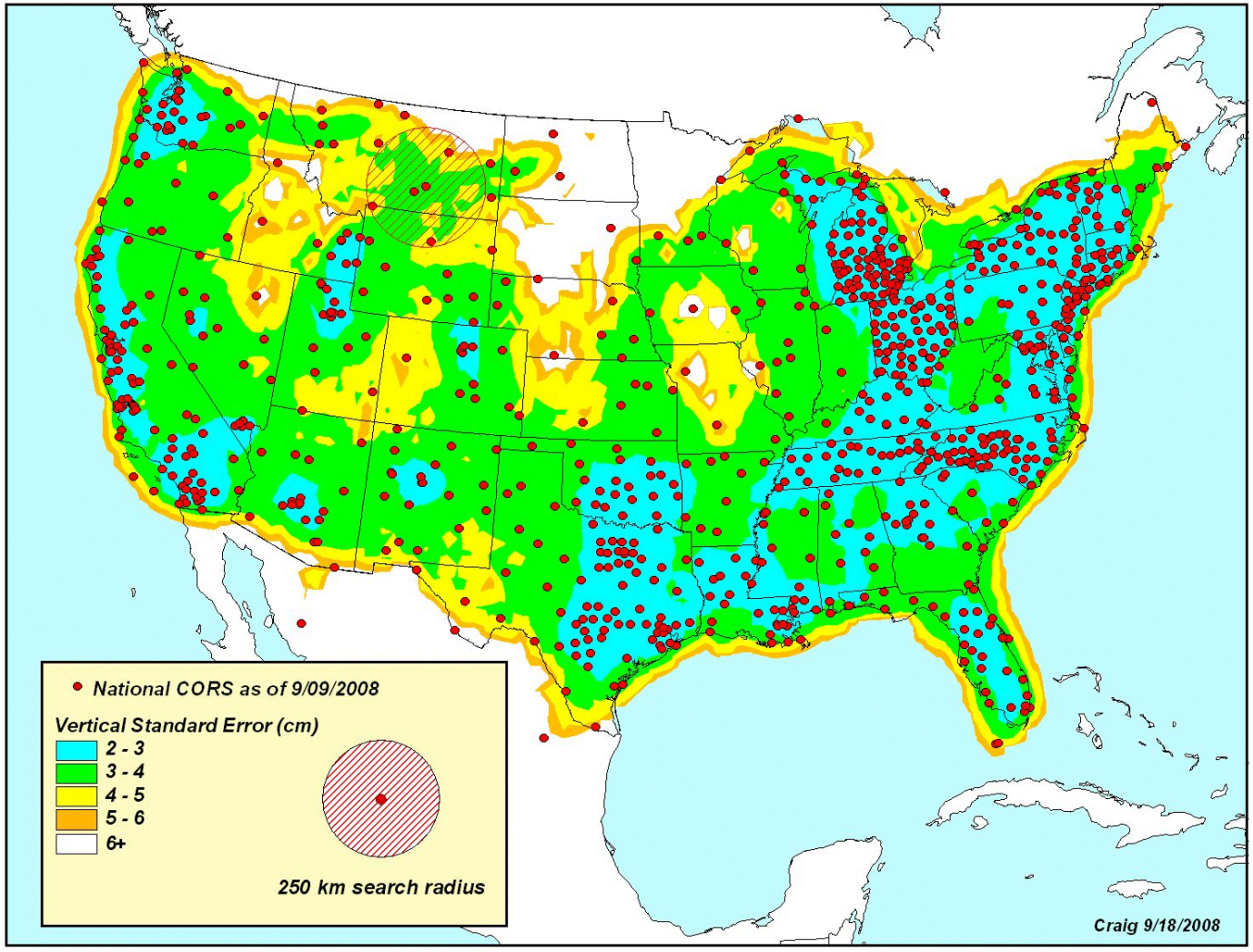
- STDERR(north) ≈ $[(1.8\text{cm} \cdot \text{IDOP})^2 + (0.05\text{ppm} \cdot \text{RMSD})^2]^{0.5}$
- STDERR(east) ≈ $[(1.8\text{cm} \cdot \text{IDOP})^2 + (0.05\text{ppm} \cdot \text{RMSD})^2]^{0.5}$
- STDERR(up) ≈ $[(6.7\text{cm} \cdot \text{IDOP})^2 + (0.15\text{ppm} \cdot \text{RMSD})^2]^{0.5}$


OPUS-RS expected horizontal standard error (cm)
as a function of distance from rover and IDOP
(15 minutes observation span)
IDOP
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
50
100
150
200
250
Distance from rover (km)
1.75 cm
1.5 cm
1.5 cm
1.25 cm
1.25 cm
1 cm

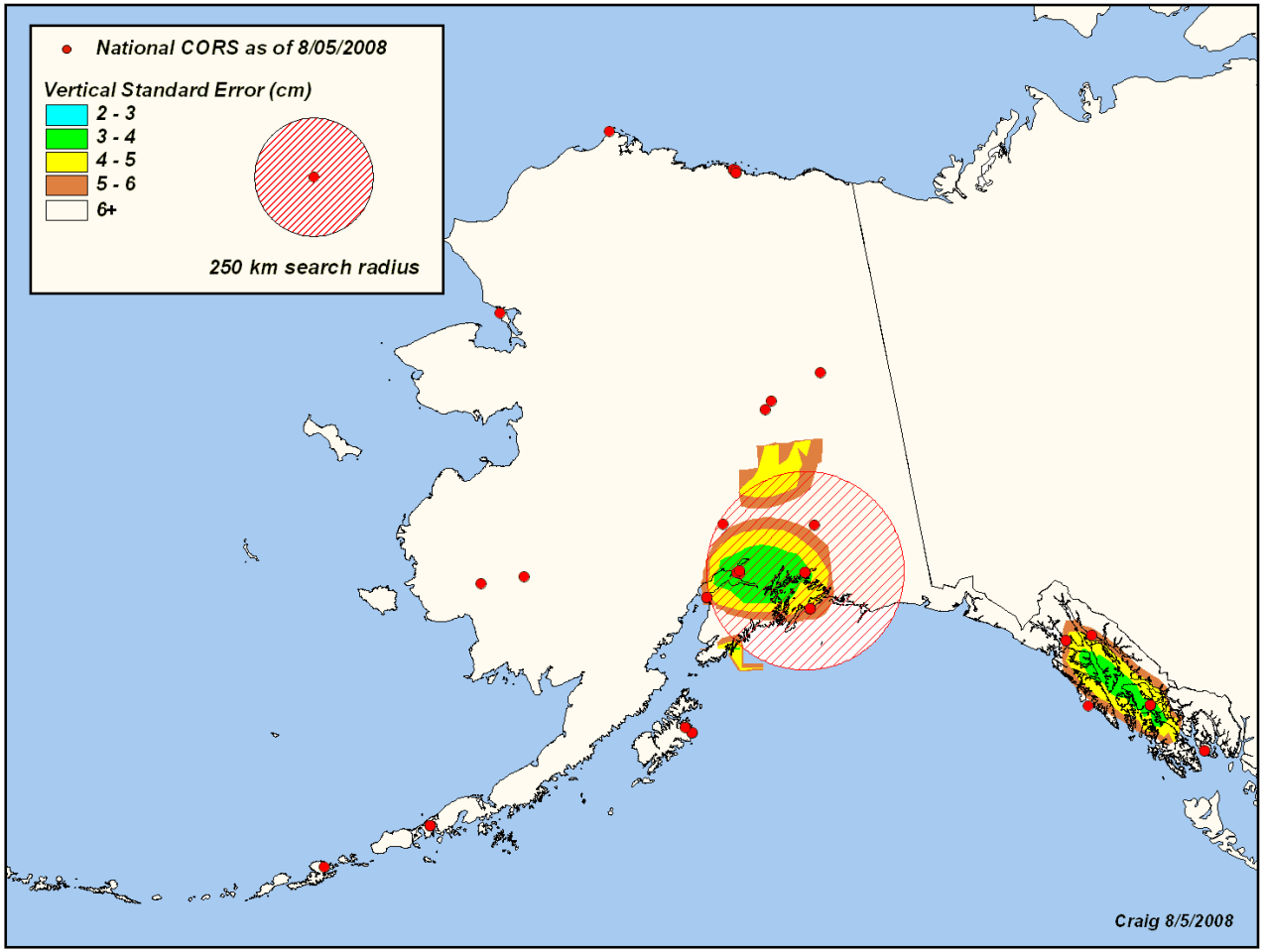
OPUS-RS expected vertical standard error (cm) as a function of distance from rover and IDOP (15 minutes observation span)



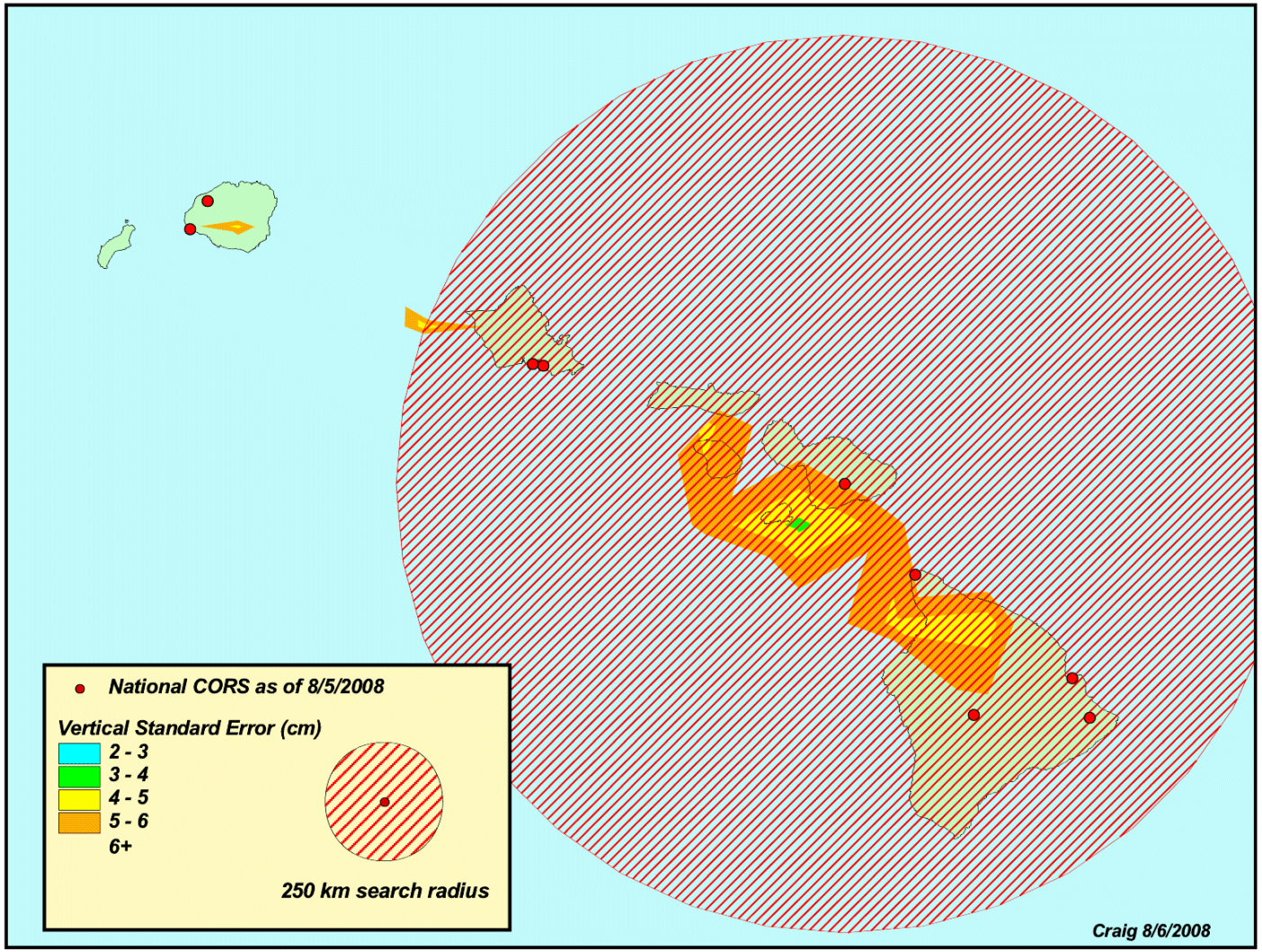
Vertical standard error achievable in CONUS when a user submits 15 minutes of GPS data to OPUS-RS



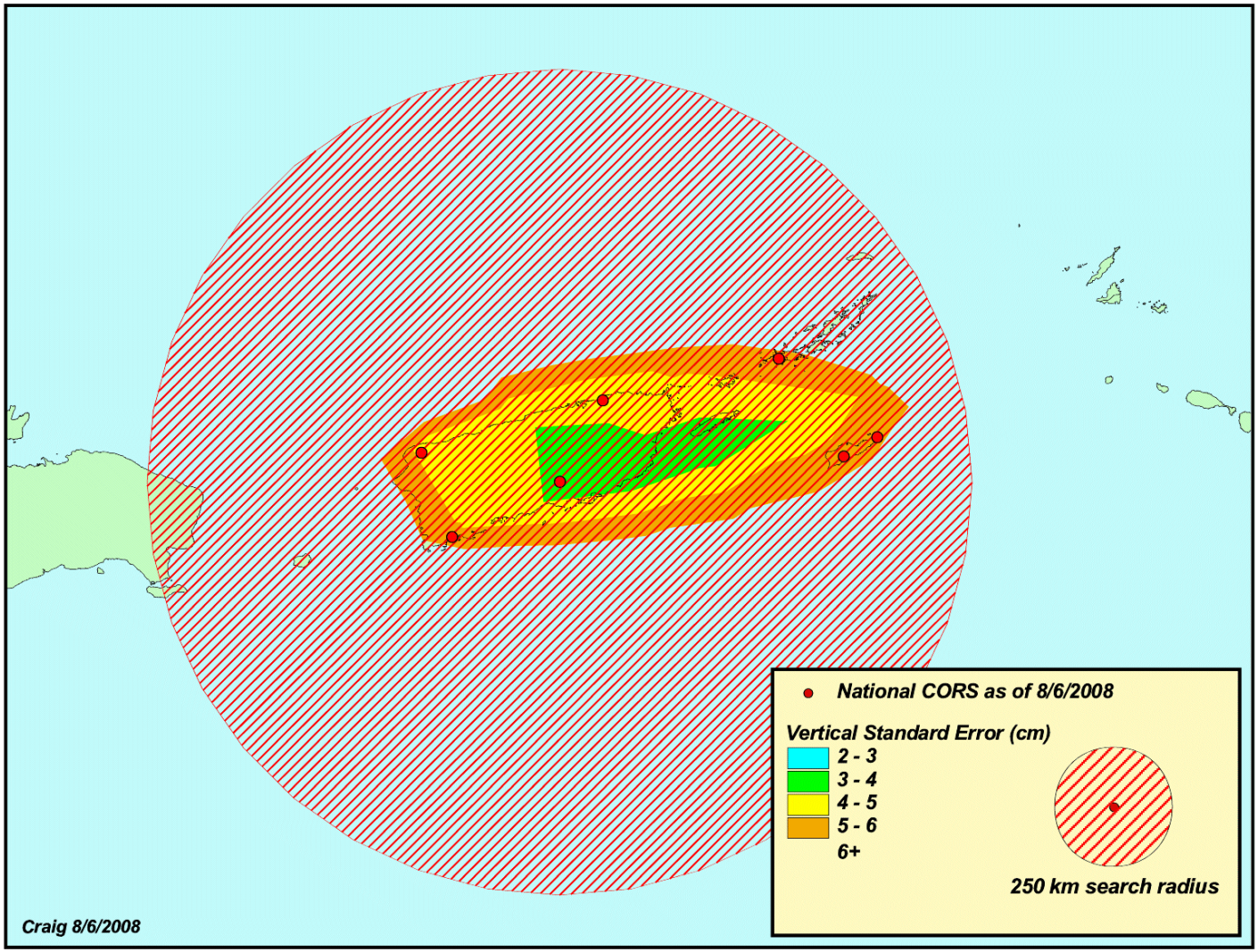
Vertical Standard error achievable in Alaska when a user submits 15 minutes of GPS data to OPUS-RS



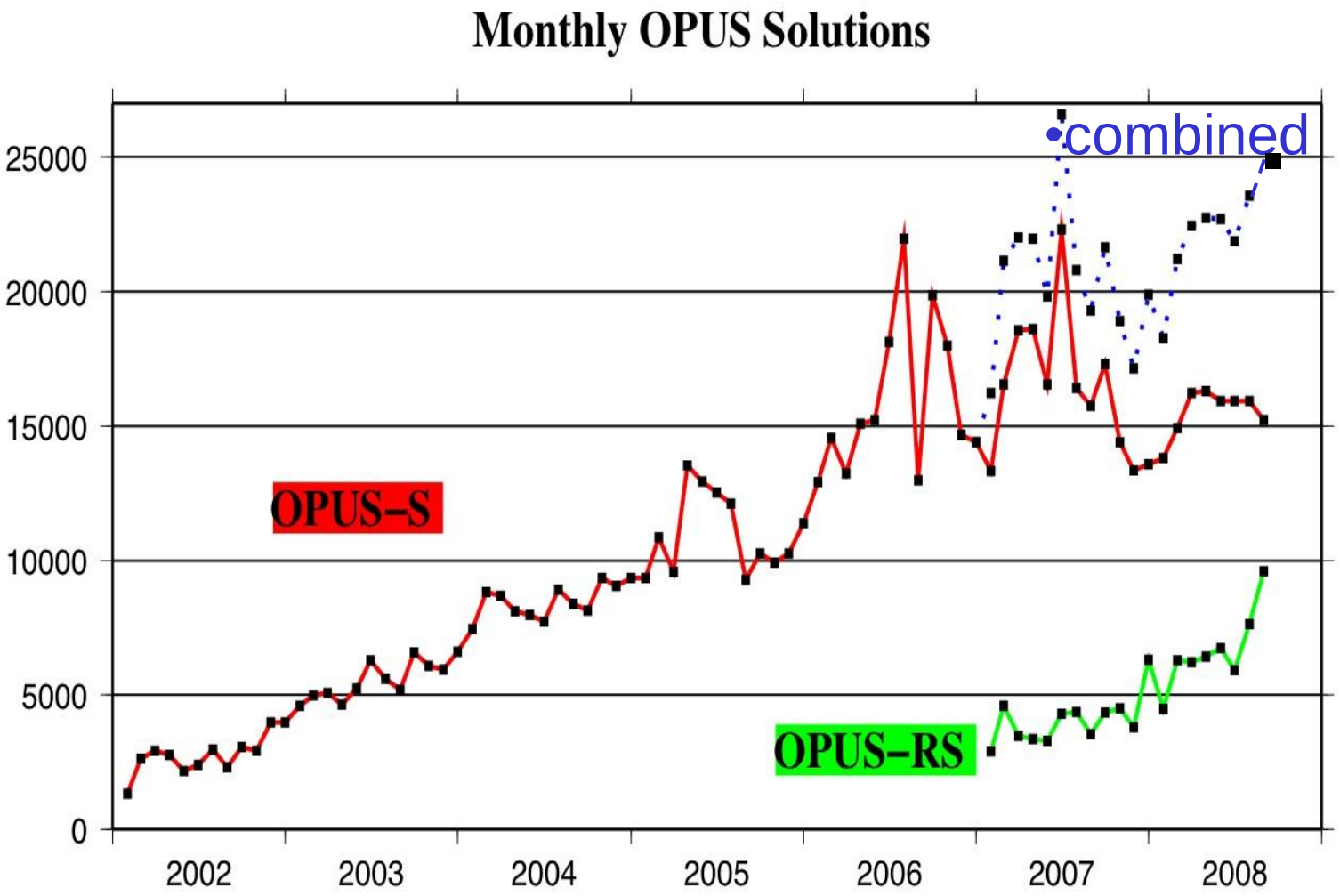
Vertical standard error achievable in Hawaii when a user submits 15 minutes of GPS data to OPUS-RS



Vertical standard error achievable near Puerto Rico when a user submits 15 minutes of GPS data to OPUS-RS



OPUS (Online Positioning User Service)



OPUS add-ons

DEFAULTS:

- $$$ receiver
- hours of data
- one receiver
- no archive
- no delimiters
- US only
- GPS only

- ¢¢ receivers
- minutes of data
- multiple receivers
- share results
- delimited results
- global results
- GNSS signals
- Δ heights

OPUS mapper
OPUS-RS
OPUS-projects
OPUS-DB
OPUS-XML
OPUS-global
OPUS-GNSS
OPUS-leveling

Operational components are available at http://www.ngs.noaa.gov/OPUS/

Prototype components are available at http://beta.ngs.noaa.gov/OPUS/

OPUS Output - *Standard*
OPUS Output - *XML*

```
<?xml version="1.0" encoding="UTF-8"?>
<OPUS_SOLUTION>
  <USER_INFORMATION>
    <USER_EMAIL>           joe.evjen@gmail.com     </USER_EMAIL>
    <SOLUTION_DATE>        February 19, 2008       </SOLUTION_DATE>
    <SOLUTION_TIME>        01:16:22 UTC            </SOLUTION_TIME>
    <RINEX_FILE_NAME>      zzyy1500.07o            </RINEX_FILE_NAME>
  </USER_INFORMATION>
  <DATA_INFORMATION>
    <SOFTWARE>
      <PAGES_VERSION>      page5  0612.06          </PAGES_VERSION>
      <OPUS_VERSION>       master3.pl              </OPUS_VERSION>
    </SOFTWARE>
    <EMPHEMERIS>           igs14293.eph [precise] </EMPHEMERIS>
    <NAV_FILE>             brdc1500.07n            </NAV_FILE>
    <ANTENNA_NAME>         TRM41249.00     NONE    </ANTENNA_NAME>
    <ARP_HEIGHT>           0.0                     </ARP_HEIGHT>
    <START_TIME>           2007/05/30  00:00:00    </START_TIME>
    <END_TIME>             2007/05/30  23:59:00    </END_TIME>
    <OBS_USED>
      <NUMBER_USED>        52955                   </NUMBER_USED>
      <TOTAL_OBS>          55069                   </TOTAL_OBS>
      <PERCENTAGE>         96                      </PERCENTAGE>
    </OBS_USED>
    <FIXED_AMB>
      <NUMBER_FIXED>       218                     </NUMBER_FIXED>
      <NUMBER_AMB>         242                     </NUMBER_AMB>
      <PERCENTAGE>         90                      </PERCENTAGE>
    </FIXED_AMB>
    <OVERALL_RMS UNIT="m"> 0.021                   </OVERALL_RMS>
  </DATA_INFORMATION>
  <POSITION>
    <REF_FRAME>            NAD_83(CORS96)          </REF_FRAME>
    <EPOCH>                2002.0000               </EPOCH>
    <COORD_SET>
      <RECT_COORD>
        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.003"> -496255.901 </COORDINATE>
        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.022"> -5510741.494 </COORDINATE>
        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.017"> 3162058.243 </COORDINATE>
      </RECT_COORD>
      <ELLIP_COORD>
        <LAT>
          <DEGREES> 29 </DEGREES>
          <MINUTES> 54 </MINUTES>
          <SECONDS> 48.44070 </SECONDS>
<UNCERTAINTY> 0.003 </UNCERTAINTY>
```

OPUS → Datasheet Concept

OPUS Concept

NGS-modeled antenna

GPS data
(4+hr, good stats)

antenna
type, height

control station
photo *

control station
description *

*optional for "existing" stations.

control station monument

OPUS website
http://geodesy.noaa.gov/OPUS
register your agency

QA/QC
datasheet review

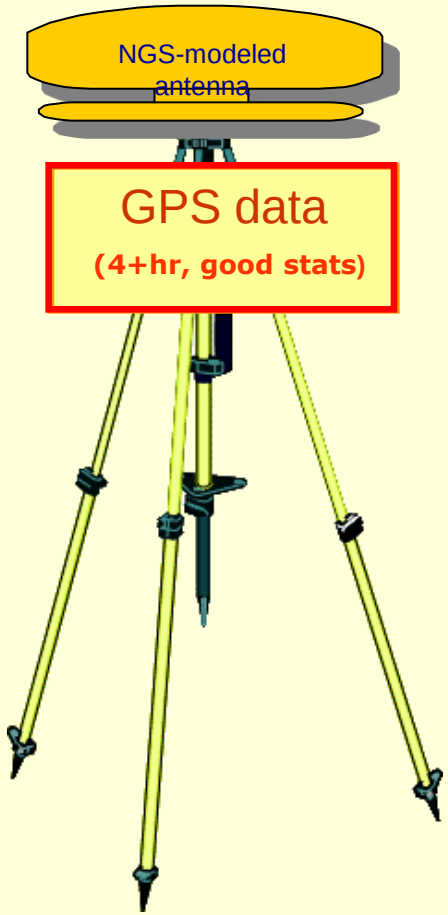
~~your~~**public** datasheet

control station requirements

Stable
Permanent
Unique
Recoverable
Safe

control station monument

GPS data requirements



"OPUSable"

4+ hours of dual frequency data

NGS-calibrated antenna

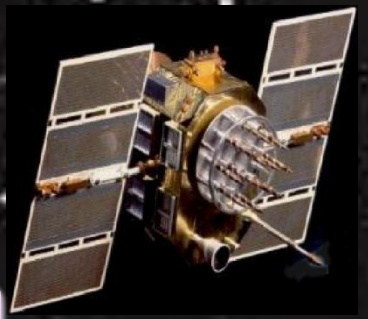
OPUS must achieve:

- ≥ 90% observations used
- ≥ 80% ambiguities fixed
- ≤ 0.02m peak-to-peak horizontal
- ≤ 0.04m peak-to-peak vertical

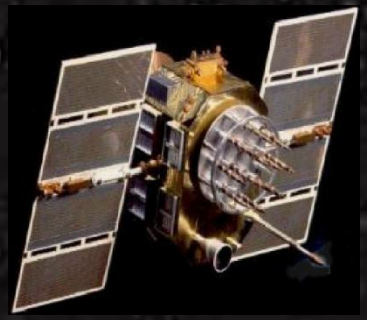
metadata requirements

*optional for “existing” stations.

Simplified bluebooking



Demonstration Application II



SURVEY DATASHEET (prototype version 1.1)

PID: OP0801414S212
Designation: ARKANSAS 2000 CENSUS POPULATION CENTER
Stability: Monument will probably hold position well
Setting: Object surrounded by mass of concrete
Description: Population center monument surrounded by a concrete slab in yhe shape of the state of Arkansas. Located in Toad Suck Park, on the left descending bank of the Arkansas River.
Observed: 2003/07/16 23:58:00
Source: OPUS - page5 0612.06

Close Up View

REF_FRAME: NAD_83(CORS96) | EPOCH: 2002.0000 | SOURCE: [Geoid03 NAVD88] | UNITS: m | SET PROFILE | DETAILS

LAT:	35° 4' 37.22978"	± 0.006 m
LON:	-92° 32' 38.55821"	± 0.019 m
ELL HT:	56.145	± 0.035 m
X:	-231949.131	± 0.020 m
Y:	-5220417.454	± 0.027 m
Z:	3644894.220	± 0.022 m
ORTHO HT:	84.245	± 0.043 m

	UTM 15	**SPC** 301(AR N)
NORTHING:	3881678.094m	82641.713m
EASTING:	541567.876m	350383.298m
CONVERGENCE:	0.26203116°	-0.31657870°
POINT SCALE:	0.99962129	0.99997486
COMBINED FACTOR:	0.99961249	0.99996605

CONTRIBUTED BY

steve.c.corley@usace.army.mil
US Army Corps of Engineers

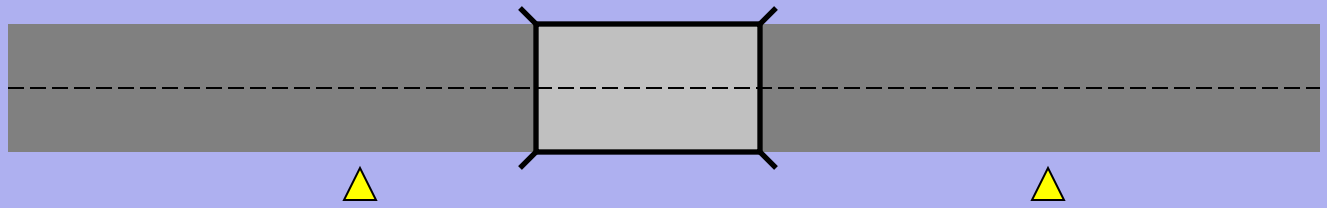
Horizontal View

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedure used.

CONTROLLING A BRIDGE SURVEY

The accompanying slides were presented
at the
2002 CORS Forum
by
Gary Thompson
of the
North Carolina Geodetic Survey.

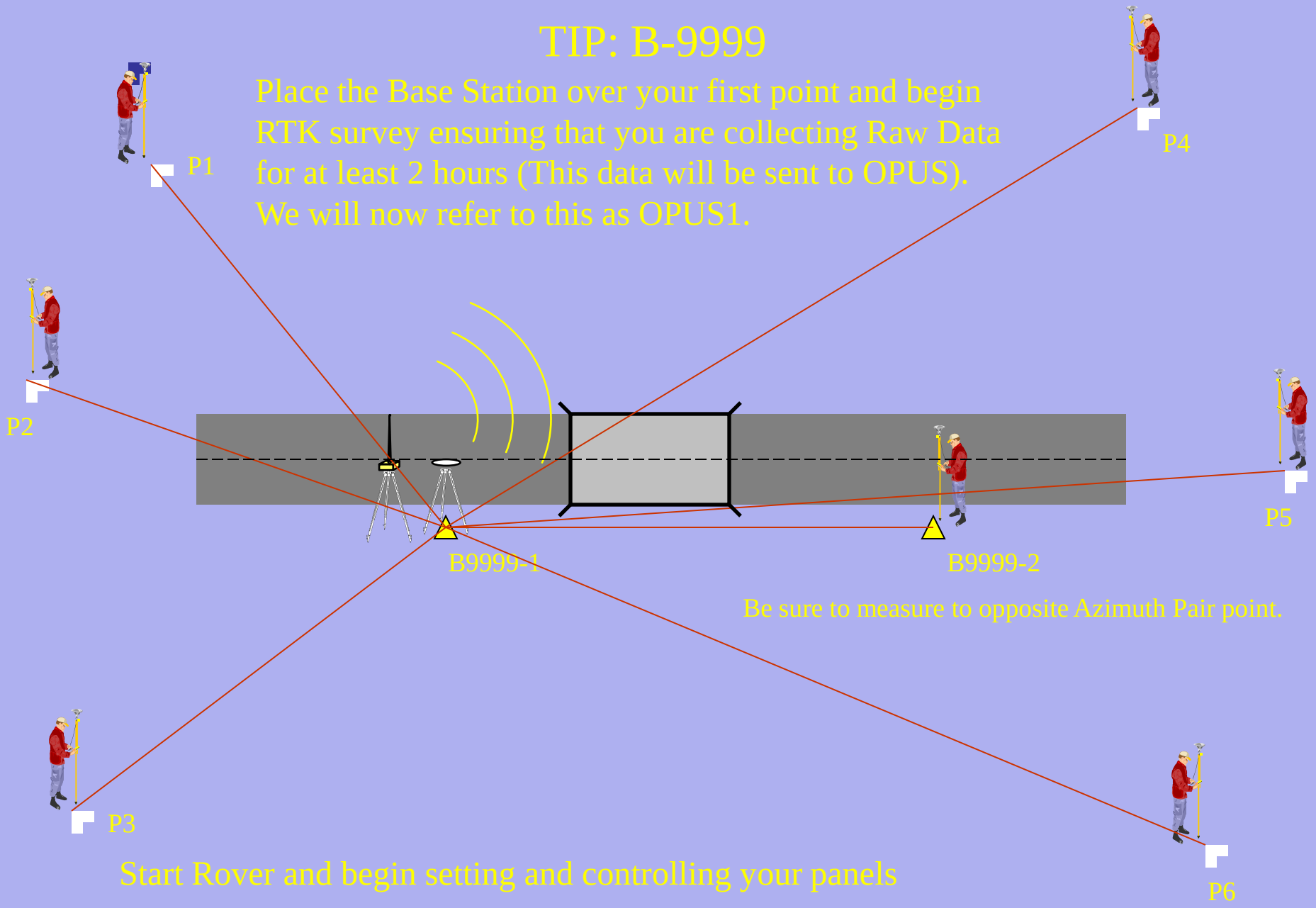
Using OPUS to control Bridges



- On a typical bridge job, NCDOT
  - Sets an azimuth pair (△ △)
  - Uses approximately 6-7 control panels ( )
  - Controls the site with 2 receivers

TIP: B-9999

Place the Base Station over your first point and begin RTK survey ensuring that you are collecting Raw Data for at least 2 hours (This data will be sent to OPUS). We will now refer to this as OPUS1.

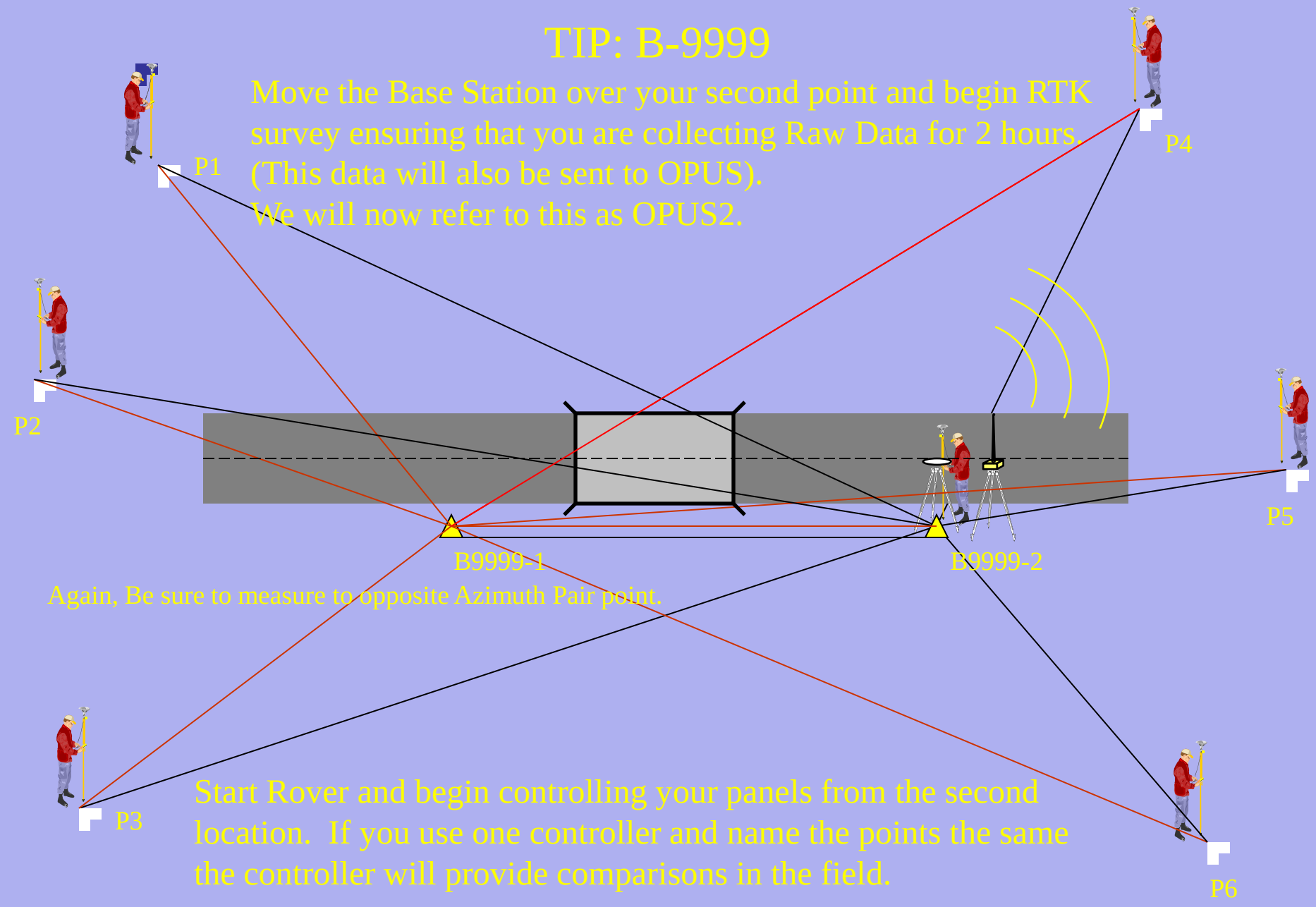


Be sure to measure to opposite Azimuth Pair point.

Start Rover and begin setting and controlling your panels

TIP: B-9999

Move the Base Station over your second point and begin RTK survey ensuring that you are collecting Raw Data for 2 hours. (This data will also be sent to OPUS).
We will now refer to this as OPUS2.



Again, Be sure to measure to opposite Azimuth Pair point.

Start Rover and begin controlling your panels from the second location. If you use one controller and name the points the same the controller will provide comparisons in the field.

Field Work is now complete.

The following steps need to be taken to finish the process:

Office Process

- Download the Raw Data and RTK dc files
- Convert both blocks of raw data to RINEX format using Trimble's utility
- Upload the files to: http://www.ngs.noaa.gov/OPUS/
- Receive the results from OPUS via email in minutes

Continued…

- Import the dc file into Trimble Geomatics Office
- Update the initial base position for the first base to the coordinates provided by OPUS1
- After a recompute, everything in the dc file should be corrected relative to the first base location (OPUS1)

Continued ...

- The position for OPUS2 is only used for comparison to what was derived from OPUS1
- Coordinates can now be utilized as needed

OPUS & RTK Savings to NCDOT

	Staff Hours	Vehicles	GPS Receivers	Cell Phones
Static	24 - 48	3	3	3
OPUS & RTK	6 - 12	1	2	*1
Savings	18 - 36	2	1	2

* The cell phone listed in the OPUS & RTK surveying comparison was not used in the survey work, but was available for contacting the office.

HOW IS THE ANTENNA HEIGHT MEASURED?

The height is measured vertically (NOT the slant height) from the mark to the ARP of the antenna. The height is measured in meters.

The ARP is almost always the center of the bottom-most, permanently attached, surface of the antenna.

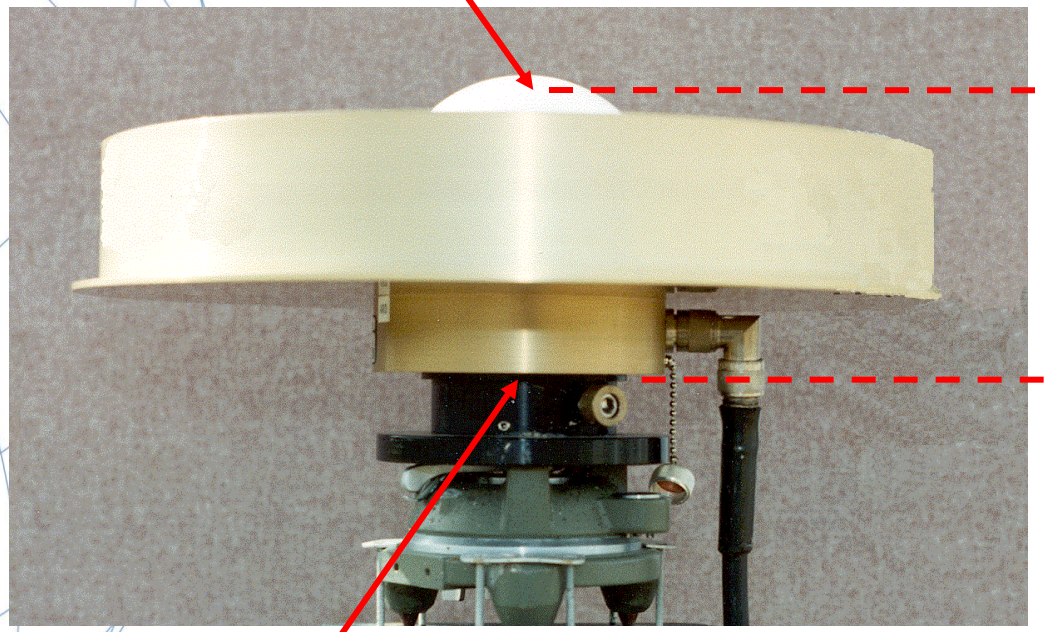
See GPS Antenna Calibration for photo's and diagrams that show where the ARP is on most antennas:

http://www.ngs.noaa.gov/ANTCAL/

If the default height of 0.0000 is entered, OPUS will return the position of the ARP.

WHY DO I NEED THE ANTENNA TYPE?

The antenna phase centers are located somewhere around here.



The antenna offsets are the distance between the phase centers and the ARP

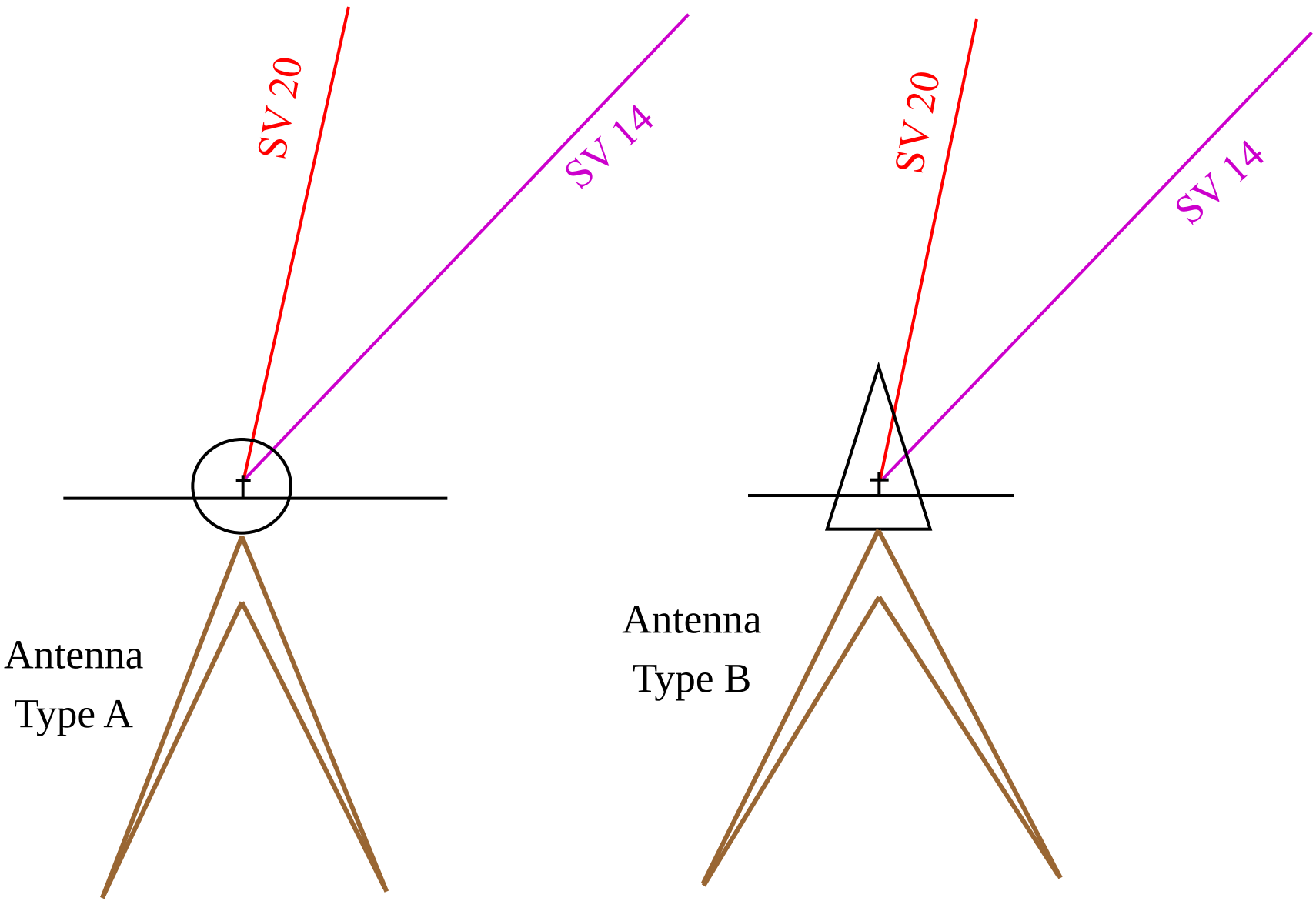
You do not need to know these offsets. They are passed to the processing software through the antenna type

The Antenna Reference Point (ARP) is almost always located in the center of the bottom surface of the antenna.

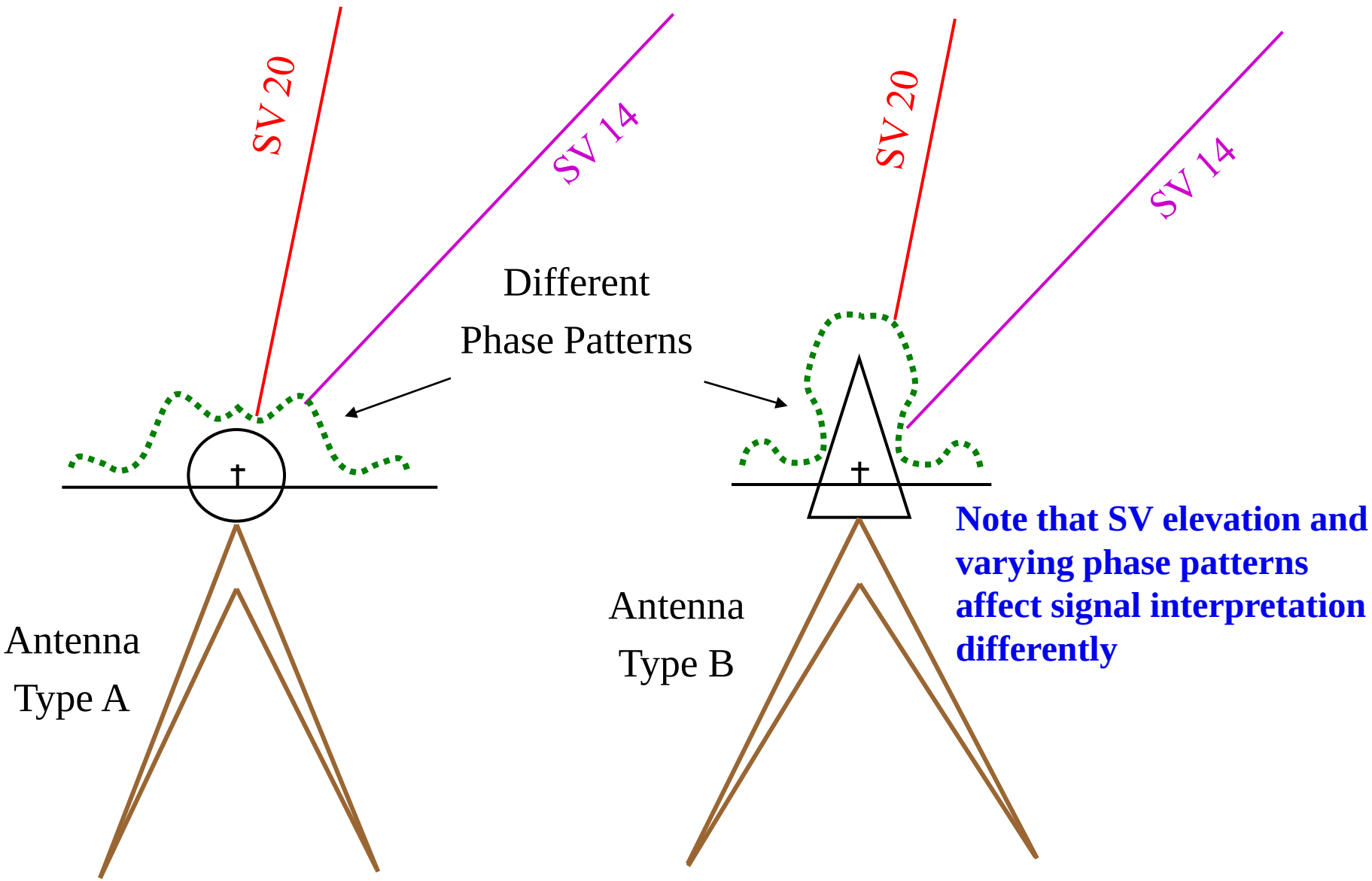
Incorrect or missing antenna type → big vertical errors

Antenna Calibration Facility in Corbin, Virginia

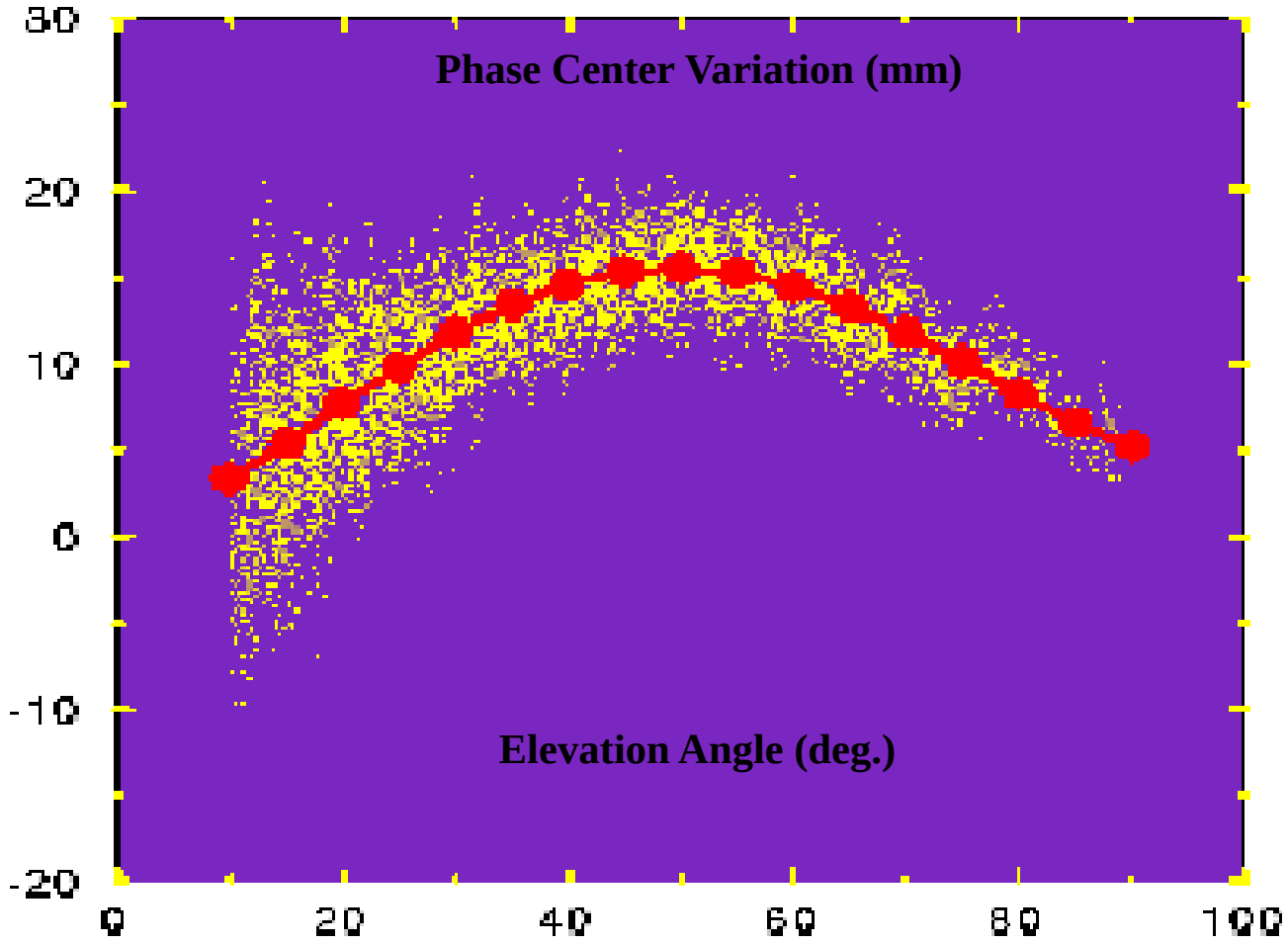
Antenna Phase Center Variation



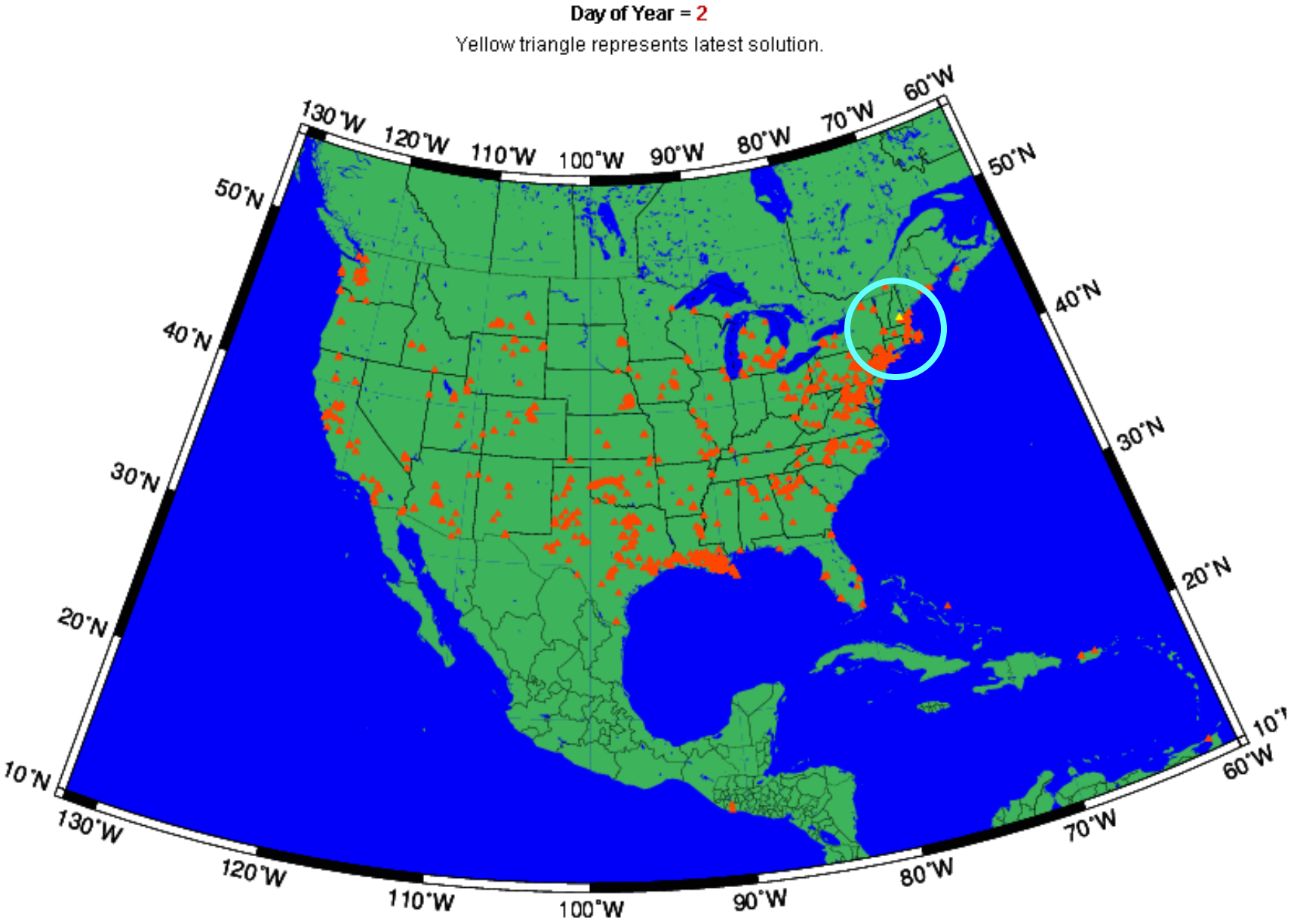
Antenna Phase Center Variation

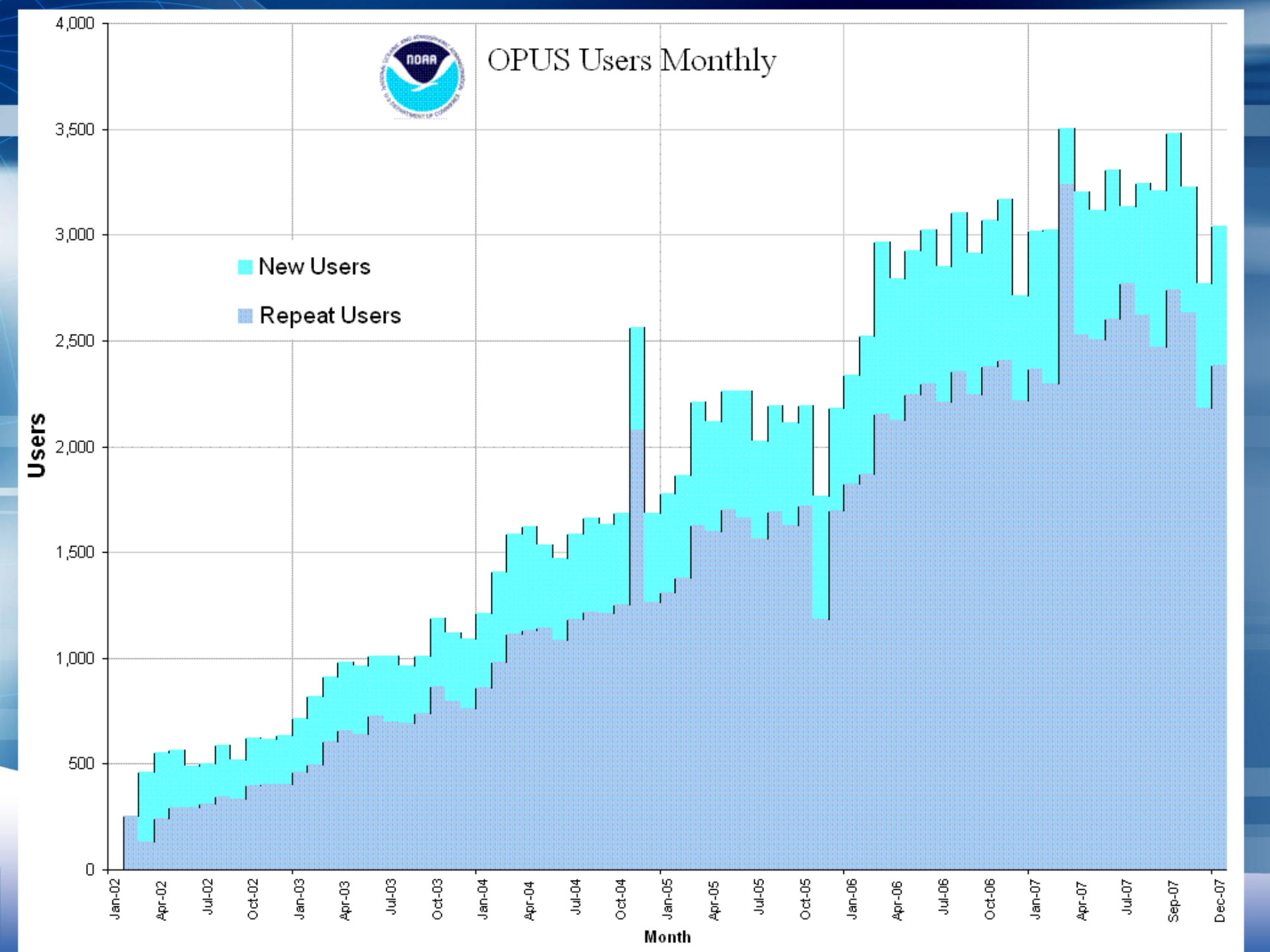


ELECTRONIC PHASE CENTER

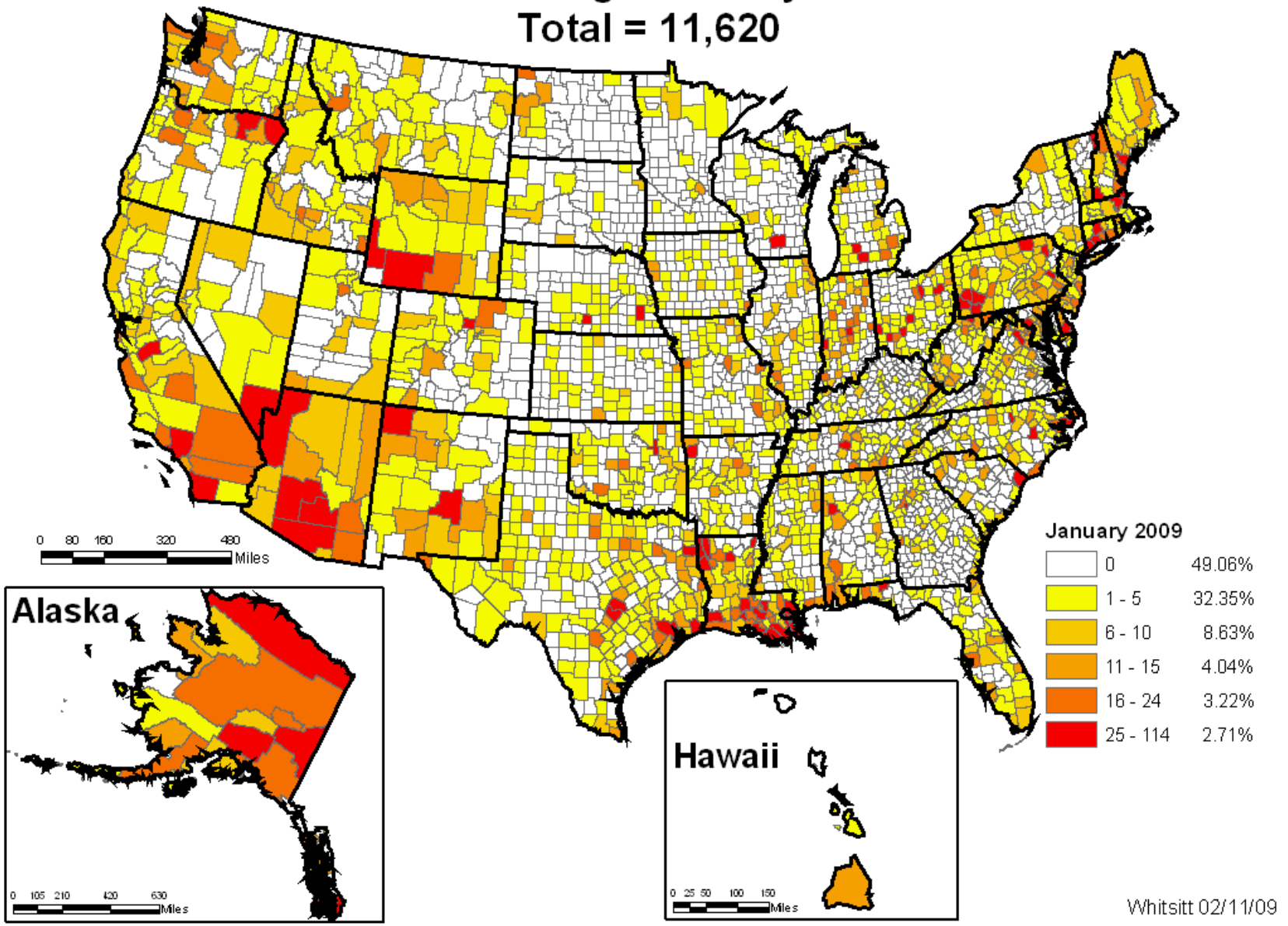


Recent Solutions




OPUS Users Monthly
New Users
Repeat Users
Users
Month
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Jan-02
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Apr-07
Jul-07
Sep-07
Dec-07

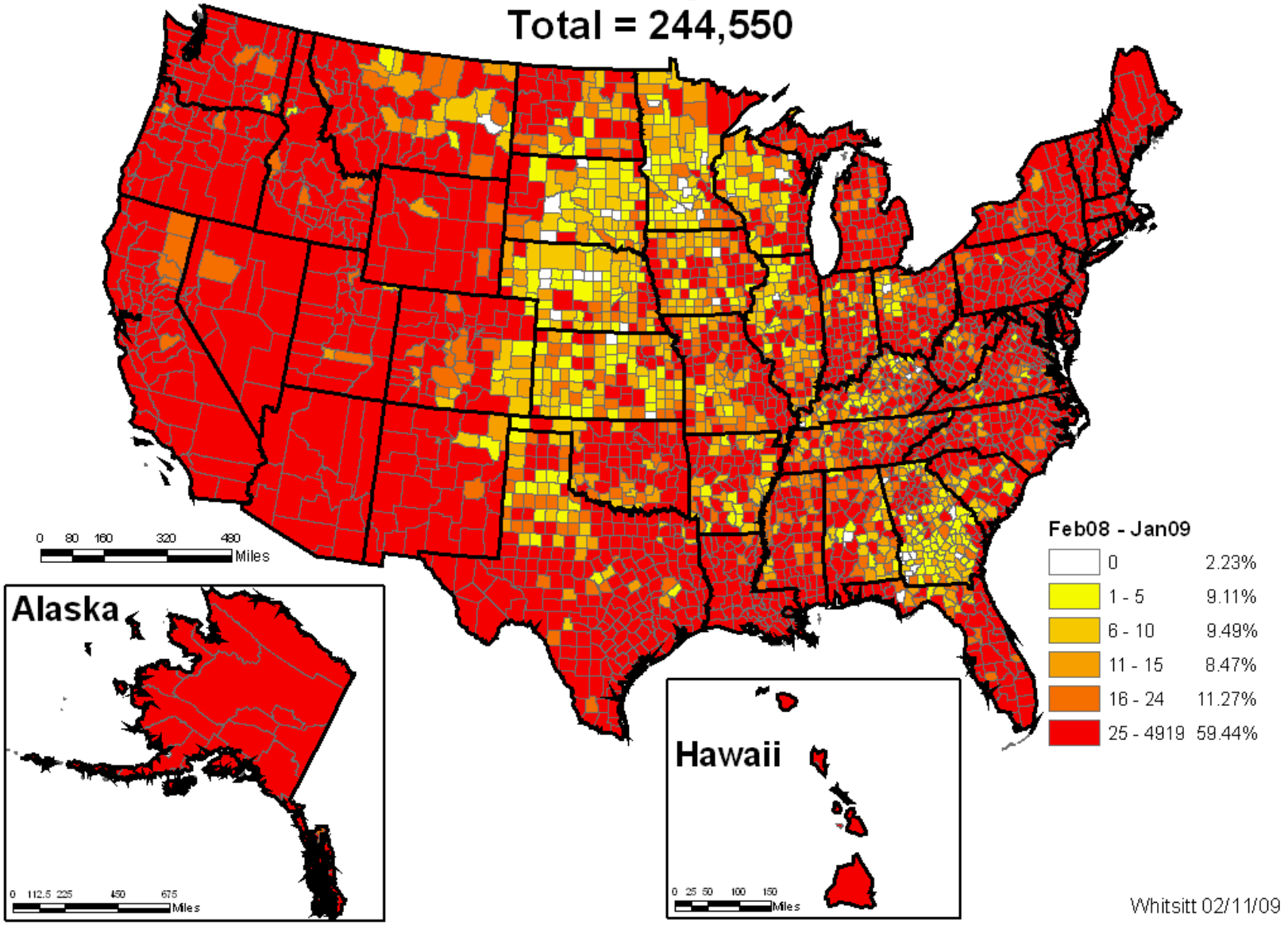
OPUS Usage January 2009
Total = 11,620



Whitsitt 02/11/09

OPUS and OPUS-RS Usage Feb2008 - Jan2009

Total = 244,550



Whitsitt 02/11/09

"OPUS Projects"—under construction

- OPUS files identified as belonging to a project are directed to appropriate directories
- Project data submission organized
- Reports sent to project managers
- Station data checked and edited as needed
- PAGES software used to process each GPS observing session individually
- Consistent coordinates for all occupied reference stations are determined by a rigorous least squares adjustment of all GPS data observed during the project , together with selected CORS data.